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SamePage: Development of a Team Training Tool to Promote Shared Understanding

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14. ABSTRACT *(Maximum 200 words)*:
This research note describes the work conducted under a Phase II SBIR contract in which an online team training system called SamePage was created. The goal of SamePage is to promote the development of knowledge and skills for enhancing shared understanding within a team. The training begins with individualized online training designed to help trainees learn about shared understanding concepts. Once trainees have been exposed to basic principles of shared understanding, they work together as a five-person team through an online scenario-based exercise to practice the principles learned during individualized instruction. The scenario exercise is periodically halted so that an instructor can bring the group together into roundtable discussions to talk about team processes and shared understanding concepts. Portions of SamePage were tested in a formative evaluation with battalion-level staff, and reactions to the system were generally positive. Six lessons learned about constructing online team-based training are presented in the last section of this note.

15. SUBJECT TERMS
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SAMEPAGE: DEVELOPMENT OF A TEAM TRAINING TOOL TO PROMOTE SHARED UNDERSTANDING

EXECUTIVE SUMMARY

Research Requirement:

The Army is reconfiguring its forces into smaller, mobile units that must make rapid decisions in an increasingly decentralized command and control (C2) environment. This strategic imperative has placed demands on the ability of small teams to work effectively under conditions characterized by imperfect information, ambiguous rules of engagement, and fluid mission requirements. Training is needed that promotes shared understanding (SU) within and across teams to facilitate information exchange, develop a common perspective, and promote the importance of assuming responsibility for team success.

Procedure:

SamePage was developed to help individuals build the knowledge and skills to promote shared understanding in their teams. SamePage is scenario-based, interactive multimedia training in which multiple methods of instructional delivery are used. It involves a mix of individual on-line instruction, computer-delivered scenario-based team training, and face-to-face discussion with an instructor. SamePage scenarios were developed through interviews with Iraqi-experienced Soldiers, and a formative evaluation was later conducted with 16 members of the 63rd Regional Readiness Command, Los Alamitos California. Four groups of participants were given a half-day exposure to the SamePage training system. The formative evaluation provided feedback concerning training content and the SamePage interface, which was then used to make revisions to the SamePage system.

Findings:

Overall reactions to the training were generally positive, and some Reserve Soldiers requested that SamePage be made available for their post-exercises the following week. The networking of the computers via local area network (LAN) was successful, indicating that the user community has two technical options—LAN or Internet—for using SamePage. Additionally, lessons learned during this project were (1) keep instructional materials short, interactive, and simple, (2) keep operators in the design loop during all stages of system development, (3) spiral development is an effective way to create system software, (4) scenarios engage trainees and provide an effective practice environment for skill development, (5) team training involves more than summing individual training requirements.

Utilization and Dissemination of Findings:

The lessons learned in this research will serve as helpful advice to researchers and practitioners who wish to build online team training. Additionally, the conceptual model of shared understanding provides a useful way to break out different targets of shared understanding that can then serve as a focus of team training interventions.

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SAMEPAGE: DEVELOPMENT OF A TEAM TRAINING TOOL TO PROMOTE SHARED UNDERSTANDING

INTRODUCTION

The Army is in the process of reconfiguring its force capability into a cadre of smaller units that are highly mobile and able to make rapid decisions in an increasingly decentralized command and control (C2) environment. This strategic imperative has placed ever greater demands on the ability of small teams to work effectively under demanding, stressful conditions characterized by imperfect information, ambiguous rules of engagement, and fluid mission requirements. In order to achieve these goals, Army leadership will need to address some fundamental problems that afflict individuals who must work together as a team (Maggart, 2004).

Based on the results of laboratory and applied research, as well as anecdotal observations from the field, five problems stand out in particular as limiting the effectiveness of teamwork. First is the bias for people working in a group setting to bring up and discuss information that is commonly known to the group versus exposing information that is unique. Thus, the tendency not to share unique (i.e., unique to an individual) information is a continuing impediment to effective team performance (Stasser, 1999). Secondly, communication is inherently effortful, so information exchange comes with overhead. It is, accordingly, often easier not to communicate with one's teammates, particularly if there is no belief in any payoff for doing so. Third, and paradoxically, the intensity of communications among teams is at odds with task and mission demands. Specifically, teams tend to over-communicate under low workload, low time pressure situations, yet go almost completely silent when task pace and time pressures increase (Wang, Kleinman, & Luh, 2001). Fourth, many studies have observed the phenomenon of "process loss" in which the resultant performance of a team is less than would be expected from simply summing the performance of the individual team members (Marks & Panzer, 2004). Finally, there is the conundrum associated with transactive memory (Moreland, 1999), which is the team's individual and collective knowledge about who has expertise on which task and where essential information is located. The problem is that the team's transactive memory can only be built up if members share information on who knows what and where information is stored. However, most are unwilling to do this since they have no confidence that their "effortful" communications will result in any benefit to their own performance or that of the team.

Shared Understanding and Teamwork

Despite these problems, there is considerable evidence showing that, whenever it occurs, shared understanding (SU) will make teams more effective. For example, evidence from communications research has consistently shown that "grounding"—the process of seeking and providing evidence of understanding in a conversation—is a necessary ingredient to successful communication and, ultimately, better performance (Hunt, 2004). In her extensive analysis of communication and team interaction measures that predicted effectiveness, Endsley (1997) identified good "markers" of success as including: having a shared understanding of the problem, ensuring that team members understand the team's goals and plans, and checking to be sure that team members share a common perspective. In their investigation of Air Force ROTC cadets

who learned a synthetic, three-person unmanned aerial vehicle (UAV task), Cooke, Kiekel, and Helm (2001) found that teams whose members understood the task from the perspective of the other positions performed better than those who did not. Thus, the extent to which teams have a shared "perspective" is another precursor to a successful team outcome.

There appears to be mounting evidence that an effective way to improve the overall performance of a team is to ensure that the members share information, appreciate one another's perspective, and assume responsibility for team performance even if it requires additional communication effort on their part. These prerequisites can be conveniently bundled under the label "shared understanding," for which methods can be developed to promote the development of these competencies and training of these skills. This is the overarching purpose of the SamePage training system.

Shared Understanding and Shared Mental Models

In representing the interactions between team members that underlie the successful sharing of information, there are several theoretical paths one can take. On the one hand, it is possible to address the exchange of information to promote "shared understanding" at a behavioral level, in which the content of the communications and the methods of information sharing take center stage. With this approach, the focus is on the overt, behavioral techniques that team members use, or can be trained to use, so that a better team outcome is ultimately achieved. That is the approach that was adopted in this project, and the conceptual underpinnings of that view will be discussed in the next section.

On the other hand, it is theoretically possible to represent SU phenomena using a more cognitive perspective, in which it is assumed that successful teams have shared mental models (SMMs). Cannon-Bowers, Salas, and Converse (1990) coined this term to account for the fluid, implicit interactions often observed in successful teams. In situations where teams must operate in environments where communication is difficult due to time constraints or high workload, having a "shared" mental model lets team members predict the information and resource requirements of their teammates (Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000).

Mental models themselves are deeply ingrained assumptions, generalizations, or images that influence how people understand the world. Mental models involve one's ability to balance inquiry and advocacy, and more generally, they are mechanisms whereby people generate descriptions of systems, explain systems, and predict future system states. From a team standpoint, SMM is organized knowledge that is shared by team members along with the shared expectations generated from this knowledge. In a simple conception, SMMs are the extent to which the mental models of the individual team members overlap. Another function served by SMMs is shared memory, so group members do not have to store all the information; rather group members only store who is aware of what information. SMMs improve performance because they enable team members to form accurate expectations for a task using a common phraseology, coordinate actions, adapt behavior to task demands, and facilitate information processing. An SMM can be considered an emergent characteristic of a group, an organized set of stored concepts, a hypothetical construct, or a set of internalized beliefs and assumptions. SMM is a latent construct that is not amenable to scaling by a single measure. We expect SMM

to be a mediating variable between cognitive ability of the team (high ability, low ability, or mixed) and team performance. Mental models are both data-driven (activated by environmental events) and concept-driven (activated by goals and expectations). In sum, SMM is a team member's mental schema to anticipate the behavior and information needs of other team members, based on their mutual understanding and shared viewpoint of the problem (Blickensderfer, Cannon-Bowers, & Salas, 1997).

The concept of a SMM has been influential in guiding extensive research in the team performance area, and there is considerable evidence to support the notion that teams whose mental models overlap, i.e., exhibit a greater degree of "sharedness," show a corresponding higher level of performance (Kraiger & Wenzel, 1997). In this regard, there is further evidence that an optimal level of overlap among SMMs exists, where if overlap is too low, there is fragmented behavior; if the overlap is too high, groupthink can result. Groupthink is more likely to occur in highly cohesive groups where the desire for unanimity overrides realistic appraisal of the situation (Cannon-Bowers, Salas, & Converse, 1993).

We further assume that a team will have multiple mental models that can be "shared" amongst its members. As articulated by Cannon-Bowers and her colleagues, team members develop mental models of their task requirements, the situation, team interactions, and so forth. There has been considerable research showing that the better teams consistently exhibit evidence of greater overlap in their mental models of both task requirements and team interactions. Importantly, there has been considerable empirical research documenting that teams develop separate models of task and team requirements, and that these models yield differential predictions of outcome. In this regard, Mathieu et al. (2000) convincingly demonstrated that a team's mental model of the task, while not predictive of team effectiveness (an outcome), was significantly related to team process, thus signifying its mediating role.

Despite the theoretical appeal of the SMM notion, it is difficult to implement experimentally. In particular, one must employ fairly sophisticated multi-dimensional scaling methods to construct representational models of individual knowledge structures which must then be applied across individuals to compute an overlap (Stout, Cannon-Bowers, Salas, & Milanovich, 1999). While doable, these analyses are not always successful, and the resulting analytical products do not always lend themselves to feasible training products. As a consequence, the present research targets the behavioral aspects of SU, while recognizing that there are attractive theoretical features of a SMM approach.

SamePage Project

This document is the final report of a Phase II SBIR contract DASW01-04-C-008 awarded by the ARI Leader Development Research Unit at Fort Leavenworth. The project is the culmination of a three-year effort in which Anacapa developed a detailed conceptual model of shared understanding (SU) in Phase I, expanded the principles underlying that model (transition period), and then implemented it as a training system, called SamePage, in Phase II. The overall objective of Phase II was to develop a validated, functional version of SamePage that promotes shared understanding among members of a five-person battalion command staff. Upon completing the scenario-based training, users of SamePage should have a better appreciation of SU, learned

basic principles underlying SU, and received hands-on experience with SU tools that can be used in a variety of Command and Control (C^2) team settings beyond the original battalion staff exercises.

These project objectives were supplemented with more specific, technical objectives:

- create field-validated tactical scenarios that challenge individual and team SU in diverse ways
- develop training protocols for nine distinct techniques for promoting SU
- develop validated measures of SU processes and scenario performance
- develop browser-based software to generate customized scenarios integrated with SU training
- develop added software functionality to control pace and feedback of scenario-based learning
- use the Public Internet to deliver synchronized scenario messages across six work stations
- determine a balanced mix of software-driven vs. facilitator (human) control of training scenarios
- create a training support environment to facilitate SamePage utilization outside the R&D setting
- conduct formative evaluation of SamePage usability and usefulness by representative users
- determine SU processes aided by SamePage training and gauge impact on performance

These technical objectives were accomplished with varying degrees of success. Overall, however, it is believed that the completed SamePage training system will yield substantial benefits for the Army if implemented on a larger scale.

SamePage as an Interactive Multi-Media Instruction (IMI) Tool

SamePage,[1] can be classified as an interactive multi-media instruction (IMI) tool that takes a blended learning approach to training (Rossett, Douglis, & Frazee, 2003) in which multiple methods and media of instructional delivery are used. Specifically, the tool involves a mix of individual, on-line instruction coupled with computer-delivered scenario-based training that is interspersed with live, face-to-face discussion. The scenario portion of the training is entirely team-based and assumes the presence of a knowledgeable instructor/facilitator (I/F). While some approaches to team training advocate an entirely (or mostly) distributed orientation (Wang et al., 2001), SamePage does not. It was specially designed to exploit direct personal contact as a way to encourage SU. Also, the techniques trained in SamePage are intended for use in operational settings where face-to-face interactions occur (e.g., briefings, sand drills, and other small group settings). In this vein, SamePage training has ties to the social constructivist theory of learning (Kim, 2001), which posits that learning occurs most effectively when students have an opportunity to interact with and share information with each other. Although SamePage exploits direct contact situations, many of the principles and techniques taught can be applied to improving communication and understanding in distributed settings.

[1] SamePage stands for Shared Mental Model Practice Gaming and Exercise.

Effective interactive media instruction consists of four instructional phases (Greitzer, Merrill, Rice, & Curtis, 2004). The first phase involves activation of prior experience, which serves to elicit associations between prior experience and new concepts. Real-word examples are used, so the student can relate new knowledge to existing knowledge (Greitzer 2002; Merrill, 2002). SamePage does this by making use of operational materials familiar to the student, such as the Operations Order, maps, and tables of friendly forces.

In the second phase, students receive a demonstration of skills, where they are first presented general information and then asked to show that they understand that information. In SamePage, the first two blocks of instruction provide information concerning the underpinnings of SU, followed by coverage of the techniques they can use to maintain and preserve SU.

The third phase, application of skills, is basically practice. Students must first recall the information they have learned and then engage in the necessary behaviors. Blocks 3 and 4 of SamePage training provide students with a complex scenario in which team members receive and send messages in order to accomplish stated mission tasks. The scenario is divided into a series of frames, each followed by a round table discussion, where students can both practice their own individual SU behaviors and receive feedback concerning their own performance and that of their team.

The fourth phase entails integration of skills, which involves transferring the learned knowledge into the job environment. For this final phase, SamePage provides several "takeaways," or physical products that can be used on the job. This includes a set of checklists (SU components, signs of SU present, SU breakdown) and a scorecard (areas of strength and weakness in SU) that provides a diagnostic on areas in which students are strong or weak.

From a training perspective, it is useful to treat SU as a complex cognitive skill that progresses through a series of development stages. Ross, Phillips, Klein, and Cohn (2005) created a five-point scale representing development from novice to expert that can be applied to examine an individual's knowledge about the team. Our version of this scale is shown in Figure 1. Each stage of learning—from novice to advanced beginner to competent to proficient to expert—can be characterized by further acquisition of observable skills and capabilities. Repeated exposure to SU scenarios and practice with the SU fostering techniques should move each individual, and the team as a whole, progressively along the scale. Figure 1 depicts a progression of SU capability along this five-point competency scale. For the scenarios discussed in this paper, students primarily advance from the novice stage of SU to the competent stage. However, students who are advanced and possess considerable tactical experience also may benefit from training, because the training focuses not only on the enhancement of cognitive skills, but on the enhancement of team skills. By design, the system is intended to promote skill development at all points along this competency scale.

The notion of SU proceeding along a competency development scale is consistent with Day and Halpin's (2004) discussion of leader development. These authors posit that historical notions of training have become rather limited, focusing as they do on bounded, short-term problems. Given the current mission flux facing Army personnel and the availability of myriad instructional technologies, "self-development" is a more appropriate framework for describing

present-day efforts at organized skill improvement. In this vein, SamePage could be considered as a *development capability* rather than a training system per se. While Day and Halpin's (2004) treatment of development was principally focused on leadership, their widening umbrella is applicable to SU as well. Indeed, the authors noted that leadership is more than just "telling others what to do," it also involves having shared understanding with one's team members. As discussed later in the report, though not intended principally as a leadership training device, SamePage—through its emphasis on SU development and maintenance—exercises many of the skills and competencies required for effective leadership.

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Novice	**Advanced Beginner**	**Competent**	**Proficient**	**Expert**
Rigid adherence to rules Little situational judgment	Situational judgment limited Can use canned guidelines for action	Engages in conscious deliberate planning Standardized and routine procedures Plan guides performance as situation evolves	Sees situation holistically rather than in aspects Sees what is most important in a situation	Intuitive recognition of decision or action Grasps situation based on deep tactical understanding
No ability to anticipate information needs of teammates	Limited ability to anticipate information needs of teammates	Exhibits periods when able to predict when own-information will benefit teammates	Usually able to predict when own-information will benefit teammates	Always able to anticipate when own-information will benefit teammates

Figure 1. Scale to assess competency in complex cognitive skills.

Elements of a Training Scenario Framework

SamePage scenarios consist of four major elements: storyline, players, content type, and events (see Figure 2). To illustrate our conception, we have populated the framework with examples taken from the SamePage trainer, which we cover in more detail later. The scenario *storyline* consists of a narrative (synopsis) and a timeline. The narrative provides a several-sentence description of the plot that will be scripted while the timeline indicates the timing and sequence of key events. Since we divide scenarios into frames (a concept discussed below), we can create a set of frame-specific tables that provides a single-source document to communicate to the entire project team—content developers, subject matter experts (SMEs), programmers, training analysts, and government sponsor.

The second column presents the *players*, both actual team members and role-played entities. The latter interact with trainees as scripted messages/communications and as contingent-responses by the Instructor/Facilitator (I/F). The number and diversity of role-played entities is a critical scenario design decision, as they add training value and realism yet they pose conceptual and programming challenges. The middle portion of Figure 2 lists the various types of *content*

that would be incorporated into the scenario. The list here is partial, and includes mission documents that might be pertinent across frames, information resources to be consulted by the trainee during the frame, advice the system would provide so that trainees do not have to be task experts, video clips that would be shown to enhance realism, scripted messages, task instructions to each team member for that frame, and a set of shared documents (e.g., table or map) that could be consulted by team members at the start of the frame and which might be updated during the frame.

Storyline	Players	Content Type	Events
Narrative: 1 or 2 sentence description of the plot In the fictional town of Belen, Iraq, 7 suspicious looking men are seen escorting 3 American contractors west on Ross Ave. There has been recent insurgent activity in the area. **Timeline:** timing and sequence of key events 1st report of contractors Follow-up report on direction and speed. Later sighting of Al Jazeera van in vicinity.	**Live Team Members:** XO, S-2, S-3, S-4, S-5 **Role-Played Entities**: BDE CDR BN CDR Kiowa Ground platoon Iraqi civil defense corps disabled vehicle detachment	**Mission Documents:** CDR's intent Mission Statement OPORD **Information Resources:** Maps, photos, role materials **Advice** **Video** **Communications** **Tasks** **Initialized shared documents**	**Software Based Events:** automated (time or event driven) instructor initiated **Team Member Events:** send comm task designation monitor comms change shared doc. view advice annotate document **Administrative Events:** start frame pause frame clear workspace resume frame

Figure 2. Framework for organizing scenario information.

This content is then rendered by the programmers as a series of *events*. We can distinguish three types of events: software, team member, or administrative. Software events are run by the system, and can either be programmed to occur on the basis of time (e.g., a message is sent 2 minutes after frame starts), in response to some event (e.g., a message from a role-playing entity is sent once the team member updates his map), or manually initiated by the Instructor/Facilitator (I/F) in the SamePAge system. The team member events are actions on the system caused by something a live team member does during the scenario frame, such as sending a communication, monitoring their communication (by pressing a tab button), annotating a document, pressing the advice button to review technical information, and so forth. Administrative events are housekeeping chores the system performs to keep the scenario running smoothly, such as starting and stopping a frame, clearing out a trainee's work space, resuming a frame, and so forth.

SamePage Training System Overview

Figure 3 provides an overview of the SamePage training system. SamePage consists of four blocks of instruction. Block 1 provides students with individual, on-line instruction in the basic concepts underlying SU. These are framed around a dimension- and process-based model of SU that will be described in the next section of the report. Block 2 provides students with an

opportunity to learn and practice nine proven techniques to enhance and promote SU. This skill-based instruction is practically-oriented, and involves a mix of individual and group-facilitated training. The group training occurs through a sharing of information that, at present, must occur under the watchful eye of a user-provided I/F. However, SamePage contains an Access relational database to help organize and retain the shared information.

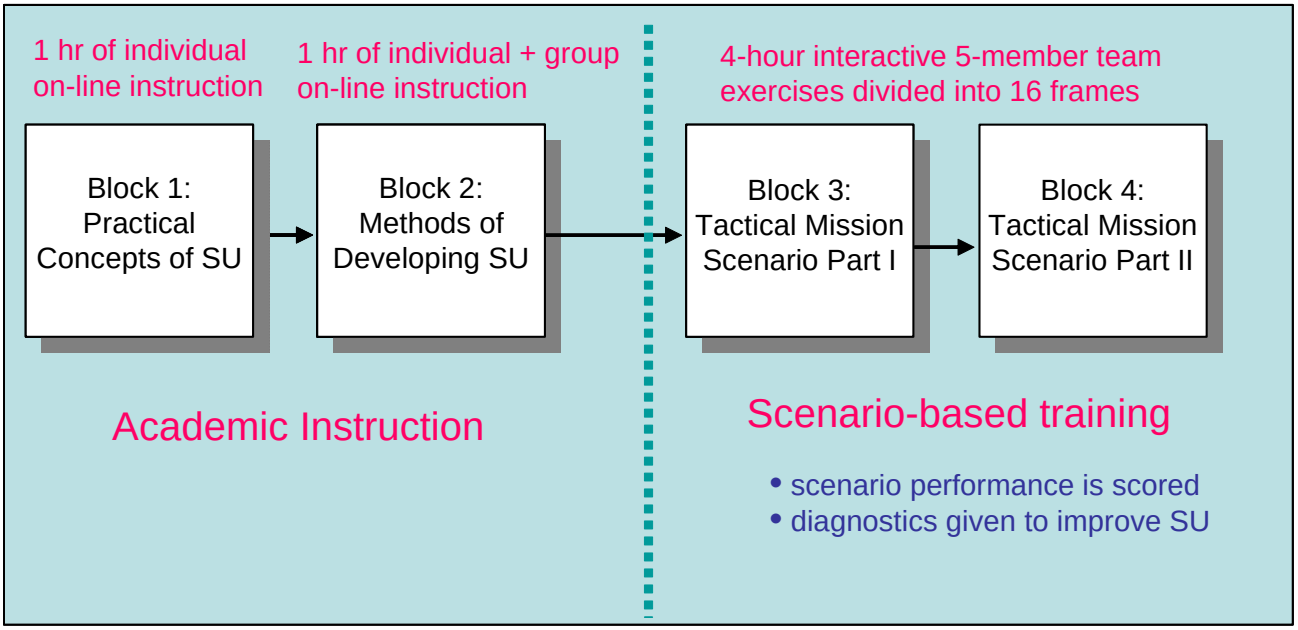

Figure 3. Overview of the SamePage training system.

Blocks 3 and 4 are the heart of the system, and each consists of a several-hour tactical mission scenario that is subdivided into eight "frames." A frame is a 4-6 minute portion of the scenario, where messages come in and the team must examine maps, orders, and share information in response to a set of scripted events. The development of the content for the storyline is quite involved, and a detailed discussion of the process is given later in the report. At the conclusion of each scenario frame, the team leaves their individual computer workstations and convenes as a group to have an I/F-moderated discussion of the events that just occurred. The training system contains a set of measures of SU, comprising a mix of subjective and objective, person-generated and computer-generated indices, that are collected and used for both diagnostic and scorecard purposes.

The SamePage training system is intended to give users a full day of instruction in the concepts, techniques, and skills needed to become proficient (or at least competent) at SU for small-unit, action teams. The scenario and software were developed for five members of a battalion staff: a team leader (the XO), an S-2 (intelligence officer), S-3 (operations officer), S-4 (logistics officer), and S-5 (civil affairs). The scenario is set in a fictional town in Iraq, where unclassified materials and maps have been used. Since the training was designed to be broadly

applicable to multiple training audiences, the scenario contains materials to help each team member get "up to speed" concerning the duties and responsibilities of the role they will be playing in the exercise. Hence, the training does not require that participants have had extensive training in the individual roles (i.e., S-2, S-3, etc.) they will be playing. In fact, it is possible that ROTC cadets and even those with little military background could experience the scenarios after receiving some initial training.

Organization of Report

The remainder of the report is organized in five sections. In the next section, we present a conceptual model of SU that outlines three components of SU (situation, mission, team), specifies three core SU processes (monitoring, communication, synchronization), and delineates some half-dozen content dimensions of SU for each component. This conceptual model provides a useful shell within which training information is provided in Block 1 of SamePage instruction.

The next section describes the activities performed to develop SamePage. This includes the methods used to create the scenarios, including in-depth discussions that were held with operational experts of the 4th Infantry Division (4ID) and 3rd Armor Cavalry Regiment (3ACR) at Fort Carson, Colorado. The report then details how training materials were developed to create instructional content, including an innovative use of PowerPoint as a multi-media storyboard. Finally, the report describes the software development processes that were followed, focusing on the technical challenges we had to overcome so that the public Internet could serve as a communications backbone for this technology.

Thereafter, the report describes the training system itself, where the discussion is organized around the content provided in each of the four blocks of instruction. Examples of screen shots of the training materials are provided, as well as describe some of the physical "take away" products that form an important part of the total training package.

This report also summarizes the results of a technical demonstration of SamePage that was held at the 63rd Regional Readiness Command (RRC) at Los Alamitos, California. Four groups of representative users, each representing a different branch specialty, were exposed to selected portions of each block of SamePage training. Their reactions were observed and recorded, and their assessments of the training system were incorporated into an extensive revision of all aspects of the system. The report concludes by offering some lessons learned from the conduct of the project, highlighting what did and did not work in developing the SamePage training system.

A CONCEPTUAL MODEL OF SHARED UNDERSTANDING

Early in Phase I, we decided to focus our modeling efforts on shared understanding, as a behavioral and *observable* cognitive phenomenon, in contrast to the more mentalistic and difficult-to-measure companion construct of shared mental models (Fischer, Spiker, Harris, & Campsey, 2003). In the previous section, we discussed our rationale behind this decision. We believe this decision has paid off in the present project, both in the form of a succinct conceptual model and as a framework for a training system.

Composite Model of Team Performance

To clarify this distinction, Figure 4 depicts what we term a "composite" model of team performance. This model characterizes, we believe, the prevailing view and core processes that mainstream theorists posit to underlie team performance. Starting from the left, a *team composition* box reflects the variables that comprise the demographics of a team, such as its relative experience level, type of task domain knowledge, degree of training, and so forth. The *team cognition* box represents the cognitive schemas that the various team members have concerning the situation and mission. We can also label this box "shared mental model," since this is where one would measure how situation, mission, and team knowledge is represented for each team member.

Mental model measurement is complex, highly theoretical, and requires the use of relatively sophisticated knowledge acquisition capabilities (e.g., Pathfinder; Cooke, Kiekel, & Helm, 2001) to gauge the degree of overlap or "sharedness" of models across team members. It has also been difficult to demonstrate empirically across multiple settings on a reliable basis. For these reasons, we elected to focus our efforts in the middle portion of the model, in which *taskwork*, *teamwork*, and the resulting *coordination* are depicted in the dotted box. These entities are behavioral in scope, and collectively represent "shared understanding." The outputs of these behavioral processes influence *team effectiveness* (e.g., efficacy, efficiency, communication flow), and ultimately, *team performance*.

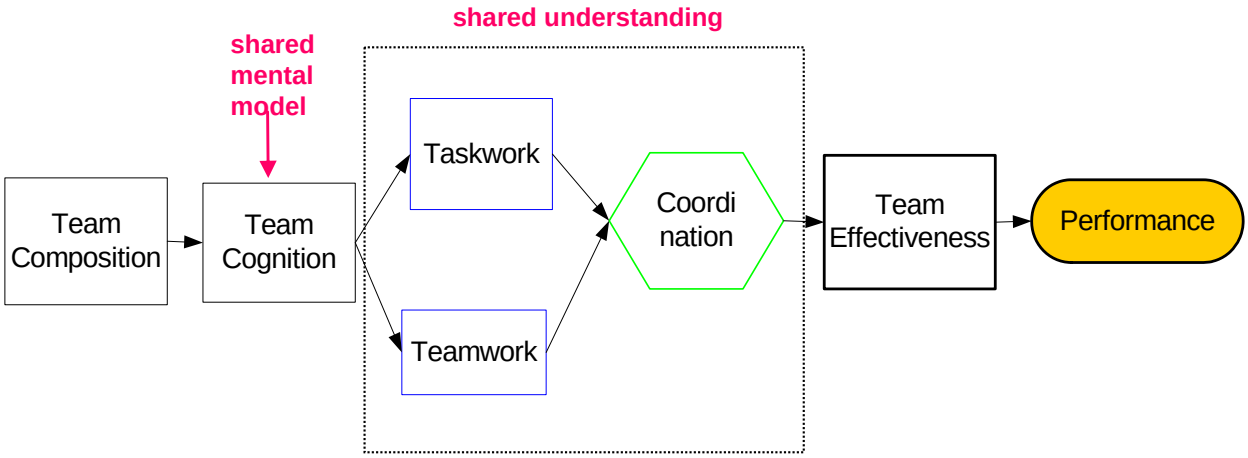

Figure 4. A composite model of team performance.

The middle box in Figure 4, and its association with the types of task behaviors that team members perform, provides the basis for the SamePage project. Though we focused our efforts on the collective result of these team activities, which we called shared understanding, it is appropriate to review their individual definitions as offered by Cannon-Bowers, Salas, and Converse (1990). Thus, *taskwork* consists of the tasks, activities, and responsibilities of each team member. A given team member's taskwork is often not visible to other team members, but its proper performance is assumed (expected) by other members unless otherwise observed. Taskwork involves the lowest level of team functioning.

Taskwork Coordination involves preplanned or agreed-upon arrangements of two or more team members to perform portions of their respective taskwork in some type of synchronous or coordinated fashion. Since Taskwork Coordination putatively controls the subsets of taskwork to be executed, there is some overlap in those two aspects of team functioning.

Teamwork refers to the interactions—verbal communication, electronic communication, visual, behavioral, exchange of work products—that occur between team members, usually at a higher level than their taskwork. Teamwork is typically not formally trained as a task *per se*, but it is essential to teams carrying out their taskwork and taskwork coordination successfully. To a large extent, our modeling of SU will focus on teamwork rather than taskwork or taskwork coordination, though all three are ultimately addressed in our model.

In the following subsections we describe our conceptual model of SU. We first outline our basic conception of SU and how that translates into something that is both measurable and trainable. Our focus is on three fundamental components of SU in a military, small-team setting. We then describe the dimensions of SU that comprise the content of team member information sharing. Conceptually, we identify 18 distinct dimensions that should form the content basis (i.e., the "what") of SU training. We conclude by discussing the processes or "how" of SU. While there are no doubt a host of diverse cognitive processes that can be explored, our modeling efforts focus on three processes the literature has shown to have the most likely impact on synchronizing information across a team.

Basic Conception of Shared Understanding

SU is conceptualized as an emergent team construct that represents the degree to which two or more individuals (team members) have synchronized their respective mental models of some content domain of mutual interest. Development of SU is considered an essential group process and has enjoyed considerable empirical support (Mohammed & Ringseis, 2001). From a measurement standpoint, SU can be treated as a "state" that has transitory properties, where its emergence is enabled through trainable cognitive skills and can be maintained through trainable monitoring and communication skills. Without dwelling on the representational form of these mental models, the focus of our modeling efforts are on the stimulus aspects of SU, the types of information that get shared, and the behavioral (and other) processes which mediate that sharing.

Antecedents of Shared Understanding

Figure 5 depicts the conceptual model that was used to structure many of the activities of this project, including the development of training content. We will have occasion to refer to this figure throughout our discussion in this section. SU neither springs from nor operates in a vacuum. There are preceding events that dictate the form and extent of a team's SU as they begin participation in a mission scenario. The antecedents in the model are depicted in the left column of Figure 5. While a number of factors can be considered, we focused on four antecedents, each with measurable aspects, in the model. These are each team member's (1) existing attitudes about working in a team, (2) their experience with teams, (3) their knowledge about teams, and (4) their own task expertise.

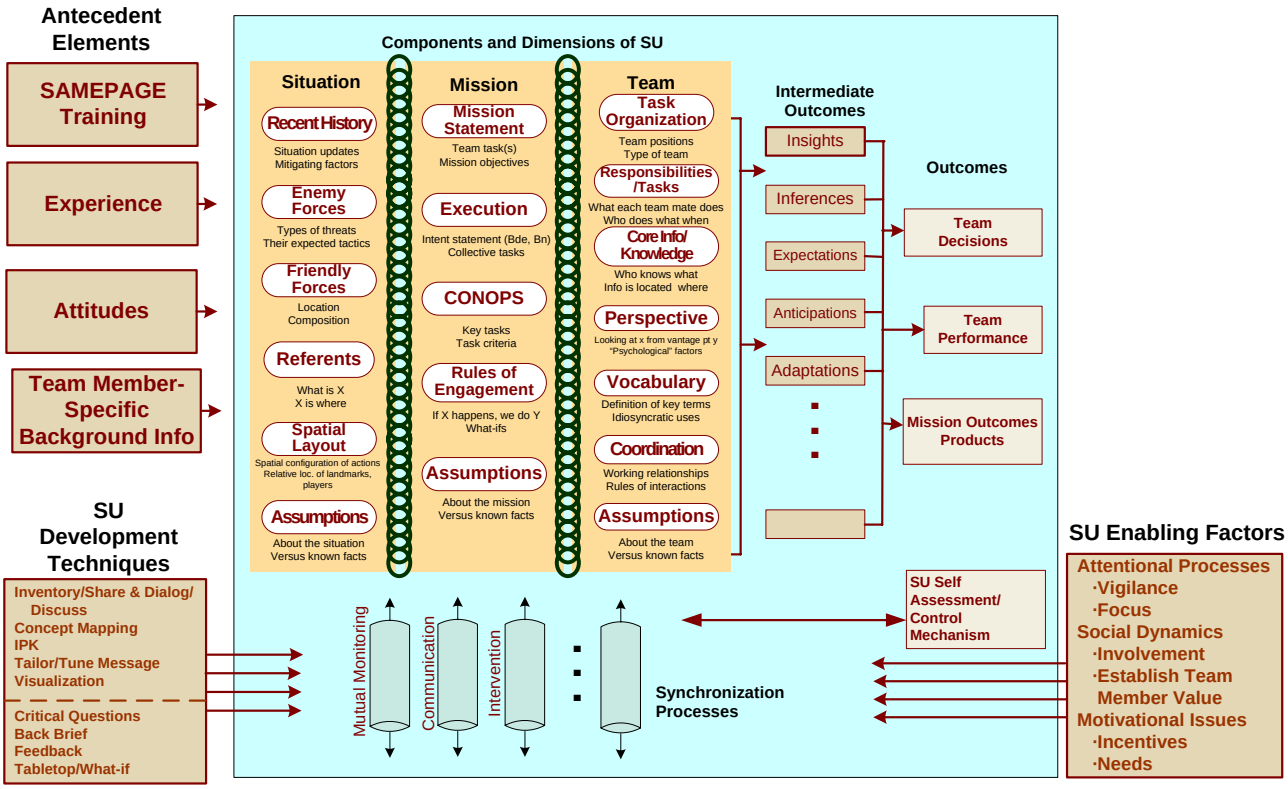

Figure 5. Conceptual model of shared understanding.

With regard to attitudes, we need to consider an individual's predispositions to share information, work cooperatively, and help other team members when necessary. Team experience includes both general experience working in a team setting as well as experience working with one or more of the team members in the present team.

Knowledge about teams, as an antecedent, also applies both to knowledge about teams in general as well as having knowledge about particular team members. In the present context, the

knowledge component can equate to having received some type of team-specific training that would be devoted to elucidating principles of team execution and cooperation. As with experience, it stands to reason that teams with greater a priori knowledge of teams and each other will be more successful in developing SU over the course of any new situation or scenario. Once SamePage training has been received by a team, the knowledge and experience gained through the training and scenarios will become antecedents for any new setting involving that team.

Finally, for expertise about tasks, the types of teams we are concerned with in this project are action teams, defined as teams in which "expertise, information, and tasks are distributed across specialized individuals" (Marks & Panzer, 2004; p. 26). Since task-specific expertise varies across individuals in these teams, there are different requirements for information sharing in advance of forming and then synchronizing a team mental model. Consequently, task expertise is another antecedent to the team setting that should be measured as a covariate when assessing SamePage effectiveness.

Components and Dimensions of Shared Understanding

In the definition of SU, we refer to a "content domain of mutual interest" as being the target on which team members focus their synchronization efforts. Within the team training and shared mental model literature the "domains" on which teams share knowledge have been variously organized around such categories as equipment operation, team goals, task design, system knowledge, and so forth (Salas, Dickinson, Converse, & Tannenbaum, 1992).

As depicted in the middle portion of Figure 5, we have organized the content domain of SU around three components: situation, mission, and team. Army C2 action teams need to first establish SU concerning basic aspects of the situation, including the background information in an operations order (OPORD). These would be established prior to engaging in any type of tactical scenario. They then must achieve SU concerning the various aspects of their mission, including their own team objectives relative to the goals of the larger force. Finally, SU is needed regarding each team member's respective roles and responsibilities on their own team. The dimensions that make up each component are somewhat different, and the next sub-section provides a more detailed look at those.

Intermediate Outcomes

SamePage seeks to target aspects of team processes that can be reliably measured without extensive instrumentation, in order to provide a tool that can be readily used by individuals who do not necessarily have a behavioral sciences background. To that end, we identify five intermediate outcomes of SU that should give us valid "peeks" into underlying shared understanding processes. As shown in the right hand column of Figure 5, these include Insights, Inferences, Expectations, Anticipations, and Adaptations. The vertical ellipses leading into an empty box signify the fact that these byproducts are by no means an exhaustive list of the immediate consequences of SU, although they should represent a good first start at such a listing.

These consequences served as starting points for constructing process measures of SU development and/or maintenance. *Insights* are innovative conclusions, new ways of thinking, and

unique points of view that can result from successful establishment and maintenance of SU over extended periods. These are comparable to the innovations that characterize successful organizations (Senge, 1990). As discussed under the SamePage training system, measures were developed to capture the qualitative and quantitative extent of these insights within the context of a given scenario.

Inferences concerning future courses of action can result from SU-stimulated processes based on deeper levels of thinking regarding the scenario information and required tasks. Such inferences would result from logical reasoning applied to assumptions, accessing and manipulating information repositories, and making inductive leaps based on recognition of patterns of data through appropriate sharing of information covered under the dimensions in the next section.

Another consequence of SU is the generation of *expectations* by team members concerning likely future actions of own units, adversaries, and other actors in the scenario (Driskell & Salas, 1992). Measures can be constructed to probe team members' expectancies and predictions of future course of events based on the sharing of core dimensions within their team mental model. As discussed later, we included some probes of "what will happen next" at the end of each scenario frame in the SamePage system.

Anticipations are a behavioral consequence of a synchronized team mental model, in which efficient behaviors would be executed in advance of potentially disruptive, destructive, or negative actions by one or more team members (Serfaty, Entin, & Johnson, 1998). Such anticipations would include behaviors on the part of the "synchronized" team member to compensate for, correct, or shore up problem areas caused by other team members or by the entire team.

Adaptations are direct actions on the part of one or more team members that are explicitly designed to promote improved performance of the team in the future. Backing up a team member is a good example of an adaptation (Fleishman & Zaccaro, 1992). While the success of such adaptations is not necessarily evident at the time, there is the intent that such alterations in activities will eventually yield long-term benefits in team performance.

Outcomes

As the team has repeated opportunities to execute the synchronization processes described later, there will be longer term consequences of SU development and maintenance that are evident later on. On the one hand, more effective synchronization of team mental models should be associated with higher quality (and possibly faster) team decisions at various points in the mission. In addition, there may be evidence of improved outcomes on the tasks assigned to individual team members. That is, it is likely the case that if the team's mental models are better synchronized, then the tasks performed by each team member should be more successful. Finally, as evidence by the multiple arrows leading into the Team Performance box, one should observe a significant, positive correlation between the quality of team decisions and the extent of team member task success with overall team performance. The latter construct will be measured via a combination of subjective estimates supplied by subject matter experts and through discrete

outcome measures explicitly embedded into the scenario, including the ultimate criterion measure of overall mission success (i.e., achievement of the team's mission objectives).

Dimensions of Shared Understanding

The 18 dimensions listed under the three components (situation, mission, team) in Figure 5 form the categories of information around which SamePage training is constructed. The three-component breakout was chosen as a way to both represent the major categories of information that appear throughout Army doctrinal documents and to offer a springboard for applying SamePage to settings beyond the Army. In this regard, it is fairly straightforward to envision any organizational setting in which its members must gain shared understanding concerning the situation, their organizational mission, and the members (team) themselves. Within the literature, having shared situational awareness (Bolstad & Endsley, 2003), a shared mission vision (Senge, 1990), and a shared understanding of one's team roles (Salas et al., 1992) are all essential to successful team performance.

These 18 dimensions form what we believe to be the most important categories of information that a small-unit Army team must absorb and share during fast-paced tactical scenarios. For the situation, these would include such dimensions as enemy forces and friendly forces, whose elements are detailed in the front sections of any OPORD. So too, the mission statement (mission), task organization, and roles and responsibilities (team) are described in different parts of an OPORD or in other mission materials. Additionally, most of the dimensions could be applied, with only minor editing, to non-military settings.

However, some of the other dimensions are somewhat less concrete, and at least part of their roots is in behavioral science. In various ways, these dimensions can "fall through the cracks" when a team is engaging in individual actions during a tactical scenario. Hence, SU on one or more of these dimensions can degrade or break down. Definitions and descriptions of these problematic dimensions are given below.

Assumptions are what team members assume about their current situation and tasking as distinct from information that is more directly based on factual evidence. Assumptions guide an individual's taskwork and teamwork behavior, must be inventoried, and hence must be "shared" in some fashion with all members of the team (Mohammed & Ringseis, 2001). Assumptions are present in all three components—situation, mission, team—of SU.

Referents are physical landmarks, "point-at-able" things that characterize the team's task environment (Cannon-Bowers, et al., 1993). Examples include a key piece of terrain, a meeting point, holding area, a building, or some physical entity that has tactical significance for the mission at hand. Team members must have a consistent model of what these referents are and where they are located within some commonly agreed upon (even if hypothetical) coordinate system.

Perspective is an important dimension for SU as team members must be aware that they will often be looking at the same physical entity, or piece of information, from different orientations or perspectives. Anyone who has ever tried to give someone directions to a meeting

place from an unfamiliar starting point has undoubtedly experienced the difficulties in achieving SU on the perspective dimension. Breakdowns in communication or misunderstandings are likely if team members fail to appreciate the impact that inconsistencies in perspective can have on how they describe concrete entities in their task environment (Blickensderfer, et al., 1997). Beyond the physical realm, perspective can also refer to psychological views of a situation, such as its immediacy of danger, or whether a given individual (e.g., a suspicious looking local) poses a threat to the team.

Vocabulary is the words that team members use to describe taskwork, teamwork, and mission objectives, and they should have consistent definitions and commonly agreed upon applications. While training within a given combat domain provides standardization of many military terms, a team inevitably forms an internal vocabulary of situation-dependent terms and idiosyncratic usages (Blickensderfer, et al., 1997). For example, whereas a term such as "rules of engagement" (ROE) may be commonly understood at a general level, team members must have a shared definition of ROE at the situation-specific level. Discrepancies in the practical applications of terminology can result in communication breakdowns and performance-degrading misunderstandings.

Responsibilities and team roles are another important dimension of a team mental model. Understanding on this dimension is important for ensuring smooth coordination of taskwork by individual team members and effective teamwork. Agreement upon who is going to do what at what time and under what conditions is another essential aspect of team functioning and constitutes a major dimension of SU. Cross-training has been shown to foster understanding and enhance performance (McCann, Baranski, Thompson, & Pigeau, 2000). The differential task expertise that characterizes action teams demands that team members not take presumed roles and responsibilities for granted without some explicit consideration and discussion in advance of the mission.

Core Information/Knowledge refers to the combination of knowledge possessed by each team member and a "collective awareness of who knows what." This is sometimes referred to as transactive memory within the psychological literature (Austin, 2003). In a practical sense, we can say that "two heads are better than one" only if the location of the increased information available from the greater number of heads the team provides is known in advance to each team member. Sometimes referred to as "expertise recognition," there is evidence that workgroups make better decisions when their team members know who is good at what task (Libby, Trotman, & Zimmer, 1987). It has been hypothesized that the specialization of knowledge that transactive memory supports allows each team member to build a deeper knowledge base in a narrowly defined area of expertise, thereby generating higher quality decisions and allowing smoother movement from task to task (Blickensderfer, et al., 1997). Importantly, measures of expertise recognition have been developed in other contexts and can be adapted for use in this project.

Rules refer to special procedures (the Y) the team can execute when a set of initiating conditions (the X) arise. Sometimes referred to as implicit coordination or taskwork coordination, these rules permit teams to engage in taskwork in the absence of explicit communication (Serfaty, et al., 1998). The ability of the team to perform individual and

collective tasks with a minimum of explicit communication is a hallmark of successful teams, particularly under conditions of high workload, time pressure, and when faced with unusual or unexpected circumstances (Wang, et al., 2001). Having a shared understanding of these IF X THEN Y rules in advance will clearly benefit teamwork processes and result in more efficient performance and reduced explicit communication.

How Shared Understanding Occurs—Synchronization Processes

Shared understanding is formed through three primary synchronization processes: mutual monitoring, communication, and intervention (see Figure 5). It should be noted that the synchronization processes that promote team SU are essentially the same core team processes that underlie much of effective team performance (Cooke, Salas, Kiekel, & Bell, 2004). SamePage training targets these particular processes because they (a) have consistent support within the team literature as being important for performance, (b) have a face valid relationship to SU, and (c) lend themselves to measurement using multiple methods.

Mutual Monitoring is the basic process by which team members observe or monitor one another's taskwork behaviors, teamwork interactions, and other communications within the team environment while a mission-task is being performed. For our purposes, a primary element of this process entails looking for signs of possible SU breakdown, such as frequent need for repeat communications, long periods of no communication, or indications of unexpected or unusual behaviors from a team member. While a common term for this process is "mutual performance monitoring," we have deleted "performance" from the label since much of the monitoring involves aspects of team member activity that are not behavioral and which must be inferred. SamePage will provide training techniques specifically designed to help team members watch for non-behavioral signs of potential SU breakdown. The mechanism for this monitoring involves comparing overt and inferred indications from the team interaction environment along the primary dimensions of SU. Consistencies would suggest a "so far so good" verdict of SU whereas discrepancies would suggest the possibility of an SU breakdown in some area. This would, in turn, necessitate the use of the other two processes described below.

Communication is the means by which mental models are synchronized in terms of the content and format of information exchange among team members. While some theorists focus on distinctions between information and control, or passive reception of information and physical action (Segal, 1995), we prefer to view communication as a standard process of exchanging information for the purposes of maintaining SU, confirming the status of SU, or restoring a currently degraded state of SU to some acceptable level. The format of the communications could include a mix of verbal, e-mail, graphics, extended text messages, face to face, or physical observation, among others. SamePage provides training to help trainees consider the most appropriate communication media.

Intervention entails a more direct means of controlling the synchronization of team mental models through behavioral adjustments (one's own behavior and that of one's team members) and feedback. Thus, if mutually monitoring is primarily observational and communication is mostly verbal, then this third process is much more action-oriented in nature. The intervention

might occur in advance of a possible SU breakdown, which is more properly called feedforward, or it could be provided after the fact as classic feedback.

While we describe these three processes as separate activities, in actuality they would operate in concert, much like a cycle of monitoring, communication, and intervention. The periodicity and relative contribution of processes in the cycle will likely depend on the type of mission being performed and the technology environment the teams are working in. With these processes serving as the scaffold for synchronization, SamePage provides training in specific methods to drape over the scaffold. Examples of methods include asking critical questions; engaging in table-top exercises or “what-ifs”; providing feedback; giving a back brief on something just heard or learned; creating, sharing and vetting organized lists; listing and diagramming relationships; listing another team member’s core information/knowledge or tasks/responsibilities and comparing lists; tailoring a message for a designated receiver; and team visualization or looking ahead. Details of these and other methods are provided in subsequent sections.

SAMEPAGE SYSTEM DEVELOPMENT

The following section describes the methods and procedures used to develop the content and software for SamePage. We first discuss how the instructional content was created for Blocks 1 and 2. Next, we describe the intricate series of steps we employed to create the mission scenarios that formed the core of Blocks 3 and 4. Then, we outline the software framework that was used for the entire system, including both client-side and server-side applications. Finally, we describe the activities that were performed to create the web-based promotional material for the system.

Storyboarding Instructional Content for Blocks 1 and 2

The model depicted in Figure 5 served as the basis for instructional content in Blocks 1-2. Block 1 addressed the conceptual aspects of SU, focusing on the definition of SU, its components, and dimensions. Block 2 was to be more skill-oriented, and dealt exclusively with the nine techniques for developing, maintaining, and restoring SU. For both blocks, the development sequence was to first create an extended narrative description of the instructional content using Word. These descriptions were then rendered in a multi-media storyboard using PowerPoint. The PowerPoint story, which contained true multi-media capabilities (video, sound, animation), was then rendered within a web-based environment using Flash, dynamic html, and JavaScript. The steps involved in developing the system software are described later in this section.

Block 1

From the beginning, Block 1 was envisioned as individual, knowledge-focused on-line instruction. Using Word, research psychologists on the project team created a series of modular explanations of various elements of the conceptual SU model. In essence, our goal was to flesh out the model in practical terms. Modules were thus created to cover (a) definitions and practical usage of the term “shared understanding;” (b) the hierarchical nature of SU components—situation, mission, and team; (c) the three synchronization processes of SU—mutual monitoring, communication, and intervention; and (d) the 18 content dimensions of SU. For each module, Word files were created that contained narrative descriptions and explanations, supporting graphics, hyperlinks to roll-over (supplemental) concepts, and practical examples. In addition, a series of questions followed each section to ensure comprehension before moving on. Appendix A contains some examples of this modular information.

While our original goal was to create instructional material that could be completed in approximately four hours, queries of Army users indicated that a 1-hour instructional period would be more realistic. With the modular Word files as the basis, our project subject matter expert (SME) then created a multi-media PowerPoint storyboard. This storyboard was intended to provide a very concrete, explicit framework that would then be used by the software developer to create the web-based content that would serve as the delivered training content.

The PowerPoint slides did a number of things to increase student interest and make the training content of Block 1 more appropriate for an Army audience. First, the extensive text descriptions were replaced with audio voice-over that drastically decreased the amount of

reading required of the user. Second, the training flow was revised so that the detailed academic points were eliminated; instead, the user only receives the barebones theoretical information necessary to appreciate the importance and significance of SU concepts. Third, extensive use was made of Army graphics and military examples in order to "draw the user in" to the importance of SU for team operations. Graphics included some of the city maps that were later used in the Blocks 3-4 tactical scenarios as well as operationally realistic examples of good and poor SU. Also, the storyboard contained references to the "job cards" that SamePage provides which specifies the signs of SU presence and SU absence when working in the field. In creating the narrative voice-over, we were mindful of the beneficial effects on learning that comes from a judicious integration of audio narration with graphic illustration (Mayer, 2001). When completed, the PowerPoint files were converted into online content.

Block 2

Block 2 was developed in a similar fashion, in which the content was first created by a research psychologist within Word, followed by a PowerPoint storyboard constructed by our Army SME. The content for this block was centered entirely on nine distinct methods for developing, maintaining, and restoring SU. Five methods had been identified in Phase I and were based on an extensive review of the SU and related literature (Fischer, et al., 2003). These included creating and sharing organized lists; listing and diagramming relationships; listing and comparing information, tasks, and roles; tailoring a message; and team visualization and look-ahead. For each technique, the Word version of the content contained a definition of the technique, training objectives, an example, an explanatory graphic, and some question-and-answer probes to assess comprehension.

During two rounds of interviews with Army operators at Fort Carson, four additional SU promotion techniques were identified. These included briefbacks, focused questions, feedback, and what-if exercises. In each case, a Word-based training module was created that contained a definition of the method, an explanation of its use and benefits, a checklist on how to apply the technique, and an explanatory graphic. A project research psychologist created the initial version of each method, with the project SME providing extensive critiquing and amplification of the Army examples.

A one-hour time period was targeted for the training in Block 2. After reviewing the Word modules, it was clear that the amount of reading and time required were too great for an Army audience. Hence, we elected to render selected content in a PowerPoint form that would exploit the learning benefits of audio narration, drag-and-drop interactivity, visual effects (transitions, fade-ins, pop-ups), and high-resolution graphics. The latter included street maps and satellite photos of the tactical area of interest for the Block 3-4 scenario.

As in Block 1, the Word modules formed the basis for a multi-media PowerPoint storyboard. The storyboard replaced the extensive text narrative with a voice-over, in which plain language (versus theoretical and academic jargon) was used to describe and explain each method. However, the original Word narratives formed the content foundation for the training material in the PowerPoint storyboard. Army examples again comprised the core of the instruction, with various graphics and animation added to promote user interest. The PowerPoint story-

board eschewed formal names of the techniques, but instead, focused on the benefits of the techniques and the "natural" way they could be employed in the field by the user. These were then given to the software developer, who converted the MP3 audio files into Flash-compatible media and rendered each PowerPoint slide as a corresponding frame within DHTML/JavaScript.

As in Block 1, the SME studied the academic material to determine the best means to integrate the theoretical principles into an interactive experience for the user. The MS Word documents were complete with the rigor necessary to develop a pedagogical approach that used experience as the primary teacher. Again, the user studies a credible analytical problem, makes a decision based on action, and only then might learn the theoretical principles that underlie the pedagogy.

Scenario Development for Blocks 3 and 4

Scenario development occurred iteratively throughout the life of the project. Because of the importance of the tactical mission scenario to the SamePage training concept and its inherent complexity, a host of issues had to be addressed before significant technical progress could be achieved. The following discussion attempts to cover these points in some detail, though no attempt is made to accurately recapture the chronological sequence of events.

Overall Considerations

Given current world events and the operational assignments of Army forces, it was agreed during the kick-off meeting that scenarios would focus on urban operations (UO) and military operations other than war (MOOTW). Moreover, we wanted to make our scenarios as currently applicable as possible, where the UO focus would require in-depth dealings with local populations. Thus, the setting would be in an urban center for which Operation Iraqi Freedom (OIF) tactics would be needed. As part of this consideration, we wanted the scenario action to require swings from tactical to non-tactical periods in swift and unexpected ways. Delving more deeply, we would be looking at specific tasks for which teamwork and SU would be needed for success. In this regard, tactical convoy operation and Improvised Explosive Device (IED) reactions became two leading candidate topics for generating scenario events.

A second issue in scenario development, and for SamePage in general, was the size and composition of the to-be-trained team. As discussed below, technical constraints limited team size to five, with a sixth station for the I/F. Beyond that, we wanted the team to reflect battalion staff duties, as might be found in a tactical operations center (TOC). Our initial thinking was that a scenario would be developed for a five-person team consisting of a team leader (XO), an S-1 (personnel), S-2 (intelligence), S-3 (operations), and S-4 (logistics). Team roles would be developed for each, in the form of informational packets, so that in-depth expertise would *not* be required to receive the training and perform in the scenarios. Reviews by the SME, and interviews with OIF-experienced Army operators (see below) confirmed most of our choices, though it was recommended that the S-1 be replaced by an S-5 (civil affairs). The S-5 has more contact with locals, which we believed would emphasize information ambiguity and challenge SU.

This team composition (XO, S2, S3, S4, S5) thus became our target, and has in fact stood in place throughout the project. In general, the XO would be the team leader and would be responsible for communicating to higher headquarters (role-played by the I/F) throughout the scenario. The S2 would perform tasks involving collection and dissemination of intelligence information, and would keep track of enemy activity in the scenario gaming area of operations. The S3 would be responsible for operational activity, including friendly troop movement. The S4 would be the logistics point of contact for the team, and would plan and monitor routes of troop convoys. The S5 would perform civil affairs tasks, and would be responsible for communicating with the indigenous population (mayor, police force, religious leaders—all role-played by I/F).

A third overarching issue in scenario development concerned the individual team member tasks and what they would be required to do. We felt strongly that successful scenarios will require all team members to do something at virtually all times, so there would be no periods of boredom nor should some team members ever feel like they are being "training aids" for the others. Thus, in constructing the scenario events, we were ever mindful of the need to have each team member have individual tasks to perform when they were faced with some "problem" at the start of the scenario. These tasks might entail reviewing a map, sending a message, looking up information, and so forth, but there would always be *something* that each team member would have to be doing as the scenario unfolded.

Fourth, we decided early on that the scenario had to be divided into smaller segments or "frames" that would serve as stopping points for the action. These frames fulfilled multiple purposes (opportunity to measure SU, "re-synch" team members, simplified scenario development), and have turned out to be one of the truly innovative aspects of our training program. Each frame would consume about 4-5 minutes of scenario action. At the conclusion of a frame, we would stop the action and take several SU measurements (described below). Trainees would then turn away from their computer workstations and convene at a roundtable, at which time some discussions would ensue concerning the actions that just occurred in the preceding frame. Observers would take additional SU measures during the discussion, and importantly, each roundtable discussion allows the team to be "resynched" so that if there is confusion about what just happened, things can be ironed out before proceeding to the next frame. As evidenced in the technical demonstration (reported later), this resynching is absolutely essential otherwise the training session can devolve into confusion. While we played with the idea of having fewer roundtable discussions, such as after every second or third frame, we finally concluded that a live roundtable discussion should occur after each frame. While it adds to the total time of the session, it is well worth it because trainees stay engaged in the scenario and confusion is minimized. There are thus multiple opportunities to share information and gain insights into how SU can be quickly lost and regained, or established and maintained, before starting the next frame. We will talk more about the nature of the roundtable discussion later on in this section.

Instructional Philosophy

From an instructional standpoint, it was important that the training scenario be consistent with the conceptual model described early and provides continuity with underlying concepts. Viewing SamePage as a system, scenario events can be considered an activating input, serving as

the “gasoline” that enables the SU training model to run. Importantly, the scenario provides a context to set the occasion for SU in the trainees by virtue of the events it encompasses, the information it provides, and the tasks and responses it requires. The scenarios were carefully constructed so (1) each trainee has important tasks to perform throughout the session with no dead periods; (2) events occur in a scripted fashion along a timeline in a way that makes contact with each of the 18 content dimensions of SU; (3) the tasks demanded of trainees are consistent with their designated role on the team; and (4) events embedded in the scenario require that SU occur in order for the team to be successful (i.e., a team member will not be able to perform a task well unless they receive input from other team members).

Embedded within the scenario is a script with phrasing intended to induce team members to make inquiries of each other that heighten SU. There were also pre-programmed prompts to individuals that induce them to engage their teammates in some fashion (e.g., to require some of the activities included in the nine training techniques) as part of the natural progression of the scenario. The scenarios were designed so that the frame ends at a natural stopping point in the action, so that measures of the immediate consequences of SU—insight, adaptation, inference, expectation—can be taken.

A key element of scenario development was the employment and placement of instructional prompts. The prompts are vital from a training standpoint, since they are devices designed to ensure continued trainee progress toward SU development, maintenance, and generalization. Scenarios were constructed to have two types of prompts, with some automatically generated by the computer based on the elapsed time in the scenario and others verbally from the I/F, contingent upon some action by a team member. We may view prompts as lying along a continuum in terms of their timing with respect to trainee behavior.

On one extreme, we have the heavily scripted prompts that are issued independently of what the trainees are doing and are tied directly to a scenario event. These prompts function as adjuncts to the training techniques by reminding trainees to engage in behaviors that facilitate one or more of the synchronization processes associated with one or more of the team SU dimensions. For example, at the onset of a scenario event, such as the appearance of a situation report, the Samepage system could prompt trainees to sketch the relationship between their own duty and that of a particular team member at some later point in time (a form of Concept Mapping). While potentially effective, these event-driven prompts have the disadvantage of treating all trainees the same regardless of their skill level and their current information needs.

Because of these limitations, we looked at the other end of the continuum, exploring the use of dynamic prompts that are contingent upon behaviors emitted by the trainees themselves. Such real-time prompts are designed to support the immediate instructional needs of the learner, and occur in the context of an interactive behavioral stream. Such prompting is certainly more challenging to integrate into the scenario, requiring greater vigilance by the I/F, so we had to be selective in the types, timing, and placement of these prompts. Nevertheless, such learner-led prompting has the potential to greatly enhance SU development as it will only give learners what they need at the time, much like a nudge, rather than consuming a larger chunk of the “information space” as event-based prompts. Moreover, these dynamic prompts have a greater ability to be titrated or faded out over the course of training. The use of procedures that fade-out

feedback over the course of training have proven to have much greater positive transfer to the criterion-job environment than techniques that attempt merely to maximize training performance in the short-term (Schmidt & Bjork, 1992). Along these lines, the early frames of the training scenario were designed with a preponderance of event-based prompts, whereas the latter frames of the scenario contained more student-contingent prompts.

Army Operator Interviews

During Fall 2004, two rounds of interviews were conducted with OIF-experienced Army personnel from Fort Carson. The first visit occurred during an ARI-sponsored Umbrella Week in which 14 officers and enlisted personnel were interviewed in individual, two-hour sessions. Participants were from the 3rd Armored Cavalry Regiment (3 ACR) and the 3rd Brigade Combat Team (3 BCT). We returned several months later to hold more in-depth, follow-up interviews with six members of the 3 ACR.

During the first visit, we solicited reactions from officers of varying specialties (Intelligence, United Ministry, Operations, Civil Affairs, JAG) concerning their experiences in gaining, losing, and maintaining SU under field conditions. The interviews began with a brief presentation of the conceptual SU model, followed by extended discussions of how the individual SU dimensions would be relevant during a typical tactical scenario. During these discussions, participants described their experiences concerning sources, symptoms, and causes of SU breakdown in the field. The interviews served to content-validate the model, adding detail in select areas, correcting terminology, and helping to further differentiate the SU dimensions. The concept of a "team" as a dynamic entity was reinforced, where the components of SU—situation, mission, team—were further delineated and enhanced.

The interviews also helped to pin down details concerning the scenario action area, which was to be based in the fictional town of "Belen" Iraq, where landmarks and surrounding terrain were taken from the actual town of Husaybah, Iraq. Because many of the 3 ACR participants had served in Husaybah, we were able to use their experiences to help define realistic scenario events and create situational information that would be both believable and tactically challenging. Many of the participants had tactical operations center (TOC) experience during OIF, and they were able to articulate how daily communications using e-mail, Secret Internet Protocol Router Network (SIPRNET), and Windows interface elements posed continual challenges to their SU. A key outcome of the interviews was the realization that precise duplication of specific geographic materials—maps, photos, sketches—is not necessary as long as the scenario events (i.e., positioning quick reaction forces, ground-based convoys, identifying and locating terrorists, meeting with local officials, etc.) ring true. Because the terrain of Belen, New Mexico is similar to Iraq, we were able to use city and geographic maps from Belen (which are unclassified) to substitute for Husaybah. The use of unclassified, though realistic, graphic materials greatly facilitated the subsequent development of the scenario.

Subsequent to the first set of interviews, we created a major portion of the tactical scenario for Block 3 (described below). We then returned to Fort Carson to interview six personnel from the 3 ACR, all with extensive experience in the Husaybah region. The participants were extremely helpful in content-validating the scenario, providing in-depth critiques concerning

tactics (e.g., use of inner and outer cordons to extract hostages), events (e.g., IED explosion, convoy breakdowns), team member roles, and external agents to be role-played.

These interviews yielded information that was vital to further scenario development. They critiqued the team member packets and helped us keep the XO-S2-S3-S4-S5 roles distinct and realistic within the context of the scenario events we had planned. They also reviewed our city map graphics, satellite photos, operations order (OPORD), and sketches, and corrected inaccuracies. Participants also reviewed our checklists that contained signs of SU presence/absence and helped refine those lists. As well, they provided feedback concerning the tasks that each team member would be performing and they critiqued the logic, sequence, and timing of scenario events that we had planned. In short, their in-depth review helped us to mold a set of scenario frames in Blocks 3-4 that would be compelling, credible, challenging, and realistic.

Creating Scenario Frames

Our original ideas for the scenario came from internal discussions among the project psychologists and Army SME concerning the types of events that would both challenge SU and be seen as realistic by Army trainees. We reviewed Web-posted Lessons Learned from recent operations in Afghanistan and Iraq, as well as DOD-sponsored summaries concerning the latest UO and MOOTW doctrine. Throughout our development activities, we continually sought a convenient medium for representing our ideas concerning the placement and sequencing of scenario events. We variously attempted using Excel, PowerPoint, Visio, and Word. Tables, charts, and sketch formats were used to indicate spatial relationships and timing. Frankly, no single source proved satisfactory, so we were often forced to combine documents with hand-drawn annotations to communicate ideas and concepts with project team members.

We created the scenarios for Blocks 3-4 by defining the big picture first, and then the fine-grained details. We started by identifying the “key events” that would occur during the scenario. For example, in Block 3, some of the key events were to include:

- Captives seen on Ross avenue
- Kiowa helicopter reports on station
- HMMWV is disabled
- Patrols report seeing activity near old hotel
- Al Jeezera van spotted
- Ambulance seen in area
- People spotted in 2nd floor of old hotel

We then sequenced events along a timeline, where a key challenge was to envision the type of information that would be made available to each team member, the other team members who would require this information, as well as determining the task requirements for each person. In constructing events, we were mindful of the need to identify “flash points” in the scenario, that is, places where team SU might break down, individual SU might degrade, or where good team SU might have synergistic effects on overall performance. To illustrate, Figure 6 shows an early attempt at sequencing scenario events along a timeline. Starting with a series of big picture

representations like that shown in Figure 6, the project SME then created moment-by-moment descriptions of events that would impinge on each team member during the scenario. For convenience, these were constructed in tabular form, where each table row covered approximately 1 minute of the 4-5 minutes for a given frame. This required many iterations and revisions as development proceeded. Acronyms are spelled out in Appendix B.

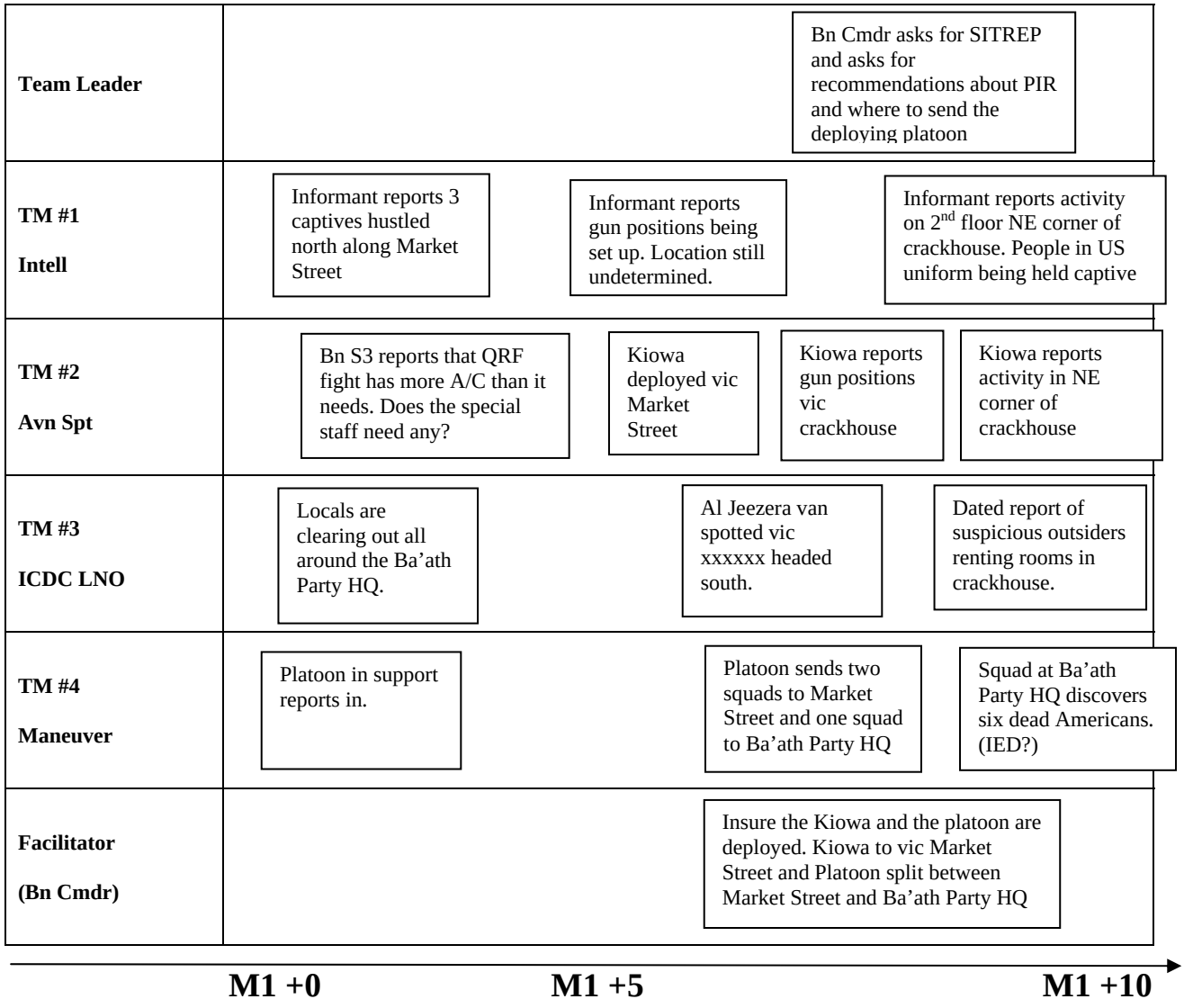

Figure 6. Example of placing scenario events along a timeline.

The tasking to evolve from the timeline into scenario content involved a micro-detail, in-depth storyboarding of the entire action, including the precise locations of all threats and friendly forces, as well as the estimated time that each message would arrive at each team member's station. This work culminated in the identification of the task requirements for each team member in each frame. As discussed later, this detailed work also helped to populate the

instruments used to measure individual and team SU. In creating this scenario detail, we took the project SME's tabular representation of events and converted them into a series of graphic-based Visio frames. An example of the graphic for Frame 1 (Block 3) is shown in Figure 7. Each graphic contains an overview of major frame events, a description of the initial information each participant will receive, the instructions for each participant, a set of expected (desired) responses, and flexible feedback depending on which actions were completed. These graphics provide a logical framework for decomposing the storyline into event-based information that can eventually be programmed into the computer and used to run the actual scenario. In the I/F guidance document (Holder, Campsey & Spiker, 2006), we provide the graphics for each of the 16 frames that make up the SamePage tactical scenario.

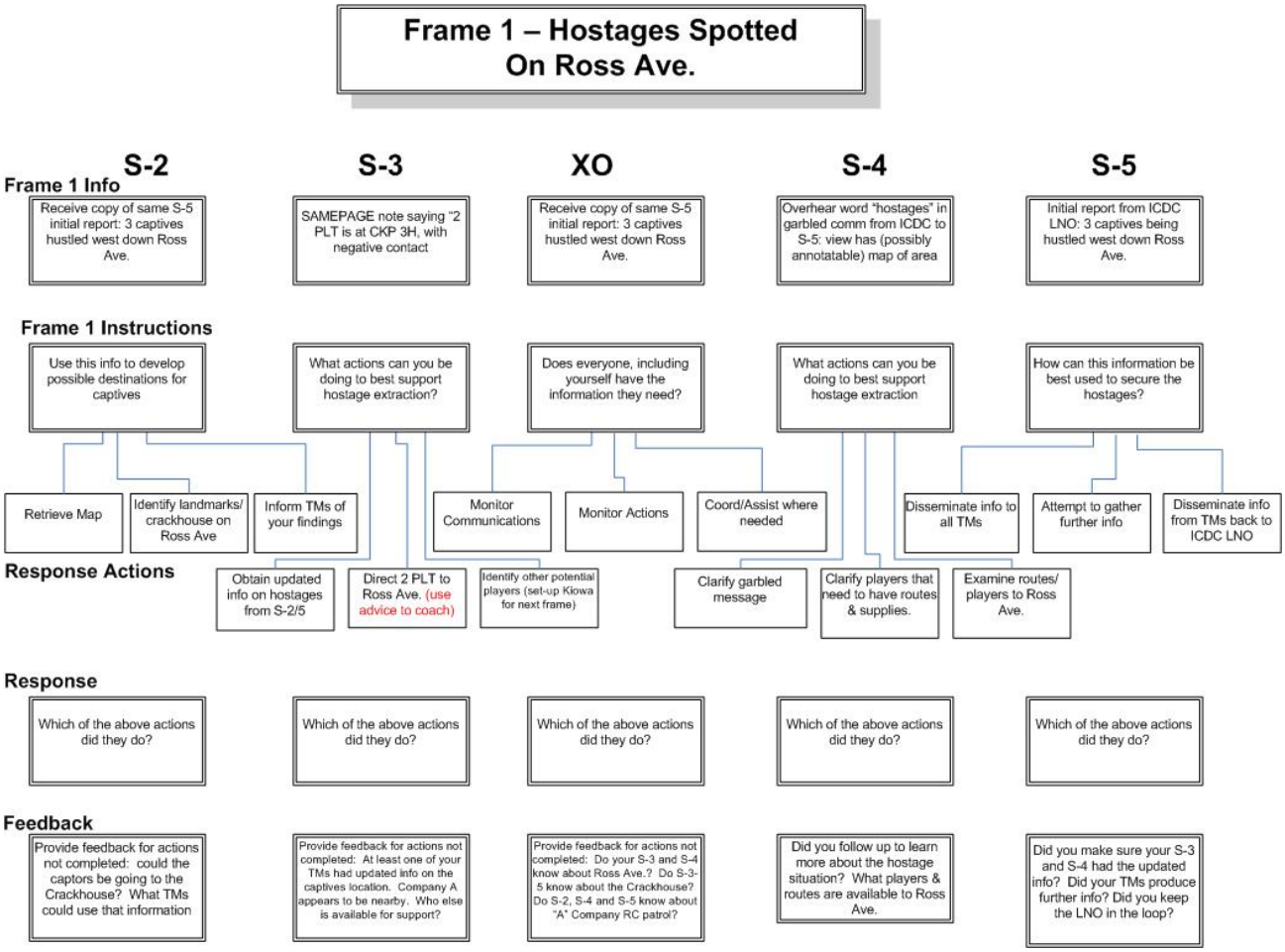

Figure 7. Example of a frame graphic to represent scenario events and team member actions.

As these frame graphics were developed, reviewed, and refined, they served to inform the entire project team concerning the stimulus and response requirements for the SamePage scenarios. As such, they provided a common representation from which SMEs, psychologists, and software developers could view the project's on-going development efforts. The Visio frame

graphics were then used as the structure to script the actual communications and timing of scenario events. The first step was to designate, for each frame and each participant, all of the scripted communications, advice, and attached information products (i.e., maps, blueprints, traffic reports, etc.) that would be required to complete that frame's tasking, along with the approximate order and timing. The second step was to script the content of each of these communications, determine if they should be timed (going out at a designated time during that frame) or I/F contingent (sent by the I/F after witnessing a specific comm or event), and enter all of this information into a table the programmers could use for content implementation. An example section from the Frame 6 table is pasted below in Figure 8. Note that contingent comms are identified in the table by highlighting their cells.

Creating Supporting Materials

Concomitant with scenario frame development, the project team worked on creating the various materials that would be used by trainees as they experienced the tactical scenarios in Blocks 3-4. These included: (1) a detailed OPORD, (2) a more condensed fragmentary order (FRAGO), (3) single-page descriptions of the roles and responsibilities for each of the five team members (XO-S2-S3-S4-S5), (4) a city map of Belen, (5) a larger scale map of Belen and the surrounding area, (6) satellite photos of key areas within Belen, (7) checklist for indications of SU presence, and (8) a checklist for indications of SU absence. Drafts of the OPORD, FRAGO, and team member write-ups were made relatively early in the project, and received extensive revisions as the scenario frames were being developed. The OPORD contained the necessary background information concerning the actions that preceded the present round of hostilities and it also outlined the friendly forces in the tactical gaming area. The FRAGO provided similar information, with principal focus on the activities immediately preceding the start of Frame 1, Block 3. We reviewed all of these documents with the experienced operators at Fort Carson. By the time the second round of interviews was completed, these documents had all been revised and fine-tuned multiple times.

The maps and photos were created as the scenario work unfolded. The maps were taken from the Google map web site [http://maps.google.com] and then doctored, using graphic editing software (Microsfoft Picture It and Adobe Photo Shop), to contain the landmarks necessary for the scenario. Sites such as the "crackhouse," Ba'ath Party Headquarters, police station, and the like were added to the maps in the relative locations necessary to support the scenario frame events. Similar doctoring was applied to the satellite photos. Minor tweaking of the maps and photos continued up to the technical demonstration at Los Alamitos (see later section). Just prior to the demonstration, a large blow-up of the city map was made and then laminated. We procured small, Monopoly-game type objects (cars, houses) that could be physically moved on the map by trainees as they engaged in their roundtable discussions between frames. This proved extremely useful in promoting the discussions of tactical events and demonstrating the presence (and absence) of SU.

The checklists for SU presence and absence were originally developed to support the second round of interviews at Fort Carson. Based on the positive reaction by the participants, and their feedback, a more complete listing of both indications was developed and they were turned

into separate documents. These lists were also laminated and used by participants during the technical demonstration of SamePage.

Advice or other if marked	Time (00:00 m:s)	Recipient(s)	Sender	Descriptor	Content
Advice	01:00	S-3		ADV: RPG Plan	**RPG Plan (see RPG sat photo):** Have 1 HMMWV from 1 PLT Group 1 and 1 HMMWV from 1 PLT Group 2 take a position just out of sight of the RPG at the North (Ross) and South (Picard) corners of 12th St.. Then, simultaneously on signal, the vehicle from each group will show itself and dart for cover. When the RPG reacts to one group or the other the kiowa will see this and attack from the East to take out the RPG.
Attachment	01:00	S-3		Attch: RPG sat photo	Attachment: RPG Sat photo. RPGpossatphoto.jpg
	01:00	S-4	DHD	Tubbs want to detain ambu	DHD [S-4]: This is Sergeant Tubbs of the 2nd Platoon disabled HMMWV detachment, the ambulance is approaching fast. You heard the reports, they are up to no good. We need to detain and check them out
	About 01:00	XO	Bn CDR	If tell CO about RPG	Bn CDR [XO]: This is Battalion Commander Schmidlap, yes we should hold the 1st Platoon until the RPG is eliminated.

Figure 8. Example of Table of Communications, Advice, and Attachments from Frame 6

Creating Measures of SU

Development of SU measures occurred considerably later in the project, as we waited until the details of the tactical scenario were fairly mature before launching into their construction. At the outset, we wanted to collect, during the scenario, both process and outcome measures of SU that would encompass individual and team levels of the construct. The frame structure of the training was instrumental in allowing us to collect these measures without intrusive interruptions during scenario action. Our plan was to collect some objective measures of SU at the end of each scenario frame (e.g., do they know where the most lethal threats are located), a subjective assessment (by an observer) of the team's SU "state" at the start of the roundtable discussion, and each team member's (subjective) assessment of their team's level of SU, with these latter two subjective assessments repeated at the end of the roundtable discussion.

Figure 9 depicts this progressive flow of SU measurement within a given scenario frame. The subjective, process assessments would be made using a five-point behaviorally anchored rating scale. The objective SU "probes" were to appear on the trainee's workstation immediately upon the conclusion of each frame. They would then make their entry using the keyboard and/or mouse. The SamePage system would retain a record of each trainee's responses to the probes. In

the completed system, answers to these probes could be printed and used by the I/F to guide discussion during the roundtable.

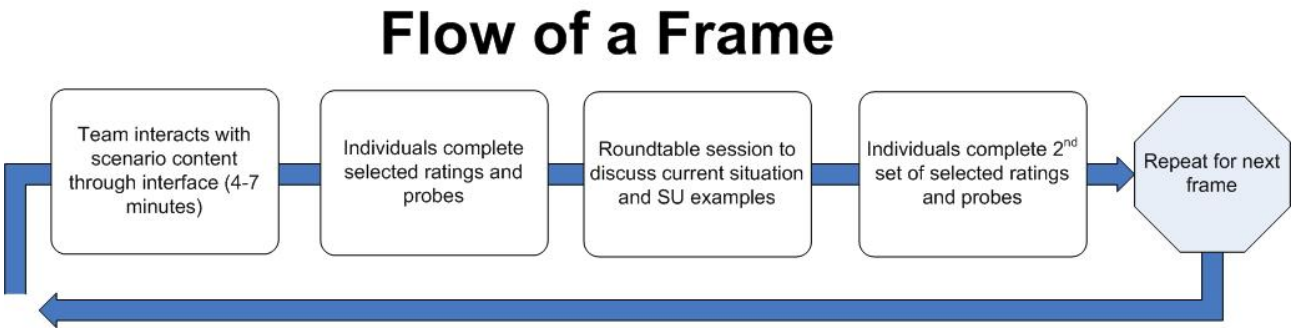

Figure 9. Logic of SU measurement within each scenario frame.

To illustrate the logic of the measurement approach, consider the sequence of events at the conclusion of Frame 1. Once the scenario stops, the trainees are first asked to rate their team's SU on a 1-5 point scale (1=mass confusion, 5= all team members in synch). They are then asked several probe questions, including:

1. Where do you think the kidnappers (and hostages) are heading?
2. Rate your confidence in that location on the 1-5 scale below
3. List 2 other possible destinations for the kidnappers

At the start of the roundtable discussion, an observer will rate the team's overall level of SU using a similar five-point scale as the one the team used for self-assessment. This rating is then repeated at the end of the roundtable, before the team returns to their workstation to start the next scenario frame. When the trainees return to their workstation, they are asked a look-ahead probe question just before the next frame begins. For the start of Frame 2, this probe would be: "list the players (not on your team) that you expect to play a major role in the upcoming frame and the role you think they will be playing. Non-team players might be the Brigade headquarters, aviation support, the Iraqi Civil Defense Corps (ICDC), and the like."

Taken collectively, the measures are intended to provide a comprehensive account of the level of individual and team SU at the end of each frame (examination of convergence and divergence of individual participant's answers), how that SU might change (and hopefully improve) over the course of the roundtable discussion, and what the state of individual/team SU is going into the next frame. When compiled across frames, the measures should provide a complete picture of how SU developed, was maintained or lost, and subsequently restored throughout the entire tactical scenario. By having both self-assessment indices and ones provided by an impartial, outside observer, the SU measurement framework is intended to be comprehensive, adaptive (i.e., small "footprint"), and efficient, where hopefully we can

"triangulate" on the actual level of SU through comparison of indices. The ability to cross-validate SU assessment is also supported with this measurement approach.

Built into the scenario itself were several more global SU behavioral assessment measures. These were contingent comms or events that were designed to be issued dependent upon the team's SU. For instance, in Frame 4, if the team does not coordinate the ICDC and the Disabled HMMWV Detachment by arranging and confirming a friendly sign with both groups by 3:00, they receive an auditory gunshot clip and fratricide message. Other examples include corrections to scripted errors in relayed locations, vocabulary, ambiguous references, misdirection by enemy entities, and the need to combine information across the team to determine that the convoy is at a false location before it enters into the trap. These assessment measures were included to provide the team with tangible examples of SU outcomes and to provide opportunities for roundtable discussion concerning how they could have been handled differently (both more and less successfully).

Software Development

Software development for this project proceeded in parallel with the creation of scenarios and scenario materials. Although the efforts were in many ways intertwined, we describe the major aspects of software development separately below. This includes the rationale for our selection of a baseline technology, assumed requirements for user hardware, the major components of our software framework, the technical issues involved in exchanging client-server messages across a network having limited bandwidth, and the progression of interface concepts that ultimately were manifested in the final SamePage product.

Technology Baseline

From the beginning of the project, we intentionally avoided using real-time collaboration tools, such as Microsoft NetMeeting, as a technology basis for SamePage. While there are certainly benefits to be realized from real-time creation and modification of graphics and text files, especially as a way to virtually ensure a "shared understanding" (at least about some things), we did not believe this was an appropriate technology model for this project. In particular, pursuit of a real-time collaboration tool has three major drawbacks.

First, *effective* real-time collaboration, as defined by working on applications at the same time, will prohibit or at least greatly restrict the use of the moderate bandwidth Internet connections or many tactical Intranets as the networking infrastructure for SamePage. Since we were attempting to position SamePage as a training system that can potentially be used in a Distance Learning environment, real-time application sharing was not viewed as an attractive option.

Second, at the beginning of this project, real-time collaboration tools were in early or fluctuating stages of development and posed technical risks that we believed would make our Phase II efforts problematic. In keeping with these risks, the costs of real-time collaboration software developer's kits and associated server infrastructure were and are quite high and not in line with a Phase II budget.

Third, and most important, we believe that reliance on real-time collaboration tools for scenario exercises would create an artificial environment that, while undoubtedly enhancing a team's SU, would steer us away from the very processes—Mutual Monitoring, Communication, Backup—that we believe will yield the highest payoff in terms of transferring to the operational environment. Indeed, these processes would play a minor role if real-time application sharing was the primary technology basis. For these reasons, we pursued the approach described below because it has the dual benefit of being (a) less technologically risky and (b) psychologically richer.

Hardware Requirements

From the beginning, it was assumed that SamePage would require six computers, one for each team member and one for the I/F. The hardware specifications for these computers are similar to a mid-range desktop or laptop computer. Thus, each requires a: (1) connection to the network on which the other team members will reside; (2) video card capable of 16-bit color at a minimum resolution of 1024 X 768 pixels; (3) 17-inch color monitor (15-inch on a laptop); (4) hard disk with 20 – 30 MB of free space; (5) sound capability; and (6) microphone. If SamePage is to be run on a local area network (LAN), a Unix-based computer is required to act as a server. If a wide area network (WAN) is used, the network provider would likely supply the server. While we originally assumed that trainees might not be physically co-located, we subsequently altered the system design with the assumption that all would be working in the same room. Because of this close physical proximity and the likelihood of audio interference, we added six headsets to the suite of required hardware for SamePage.

Software Framework

Though the final software design was dictated by training requirements, we anticipated from the beginning that a mix of commercial, open-source, and customized software applications would be used to implement SamePage. In the end, a set of open-source, Unix-based server-components combined with a mixture of commercial and customized client (team member)-based applications comprise the final overall SamePage system.

The SamePage server-side applications implemented with standard, open-source Unix components include: (1) a database-driven scenario controller; (2) the scenario timer and master clock; (3) a team member connection monitor (to detect team members that have become disconnected from the network); (4) communications components; (5) a shared document server; and (6) a team member activity monitor (to display a team member's current task to other team members). The scenario controller provides a time-based event generator that is operated through the I/F workstation. This allows the I/F (through the I/F client application) to schedule a series of automatically triggered events or insert single discretionary events. The server-based communications component uses simple custom protocols to coordinate the exchange of messages between the I/F, team members, and scenario controller. These messages might include email-like exchanges of text and graphic files, audio communications, and other content distributions initiated by the scenario controller, I/F or individual team member.

The client-based applications running on the individual team member and I/F workstations implement the controls, displays, and protocols that comprise the user interface for each team member and the I/F. We reviewed several development environments for these client-based applications, such as C#, C++, and Visual Basic, among others. But for reasons described below, we selected the Microsoft technology called hypertext markup language (HTML) applications.

In recent years, web- and browser-based applications have become integral to many organizations. In part, this is due to advantages provided by the Internet infrastructure that aid application deployment and end-user access. It is also due to the ease with which relatively complex user interactions can be developed using the browser-based technologies of HTML, CSS (cascading style sheets), and JavaScript manipulation of the DOM (document object model). These three technologies have collectively come to be known as dynamic HTML (DHTML) and form the basis for Microsoft's HTML applications (HTA).

A frequent impediment to the use of browser-based applications is the security environment in which the application must run. Under normal circumstances the browser prevents access to storage media and operating system services. With HTAs, the developer has control over the security environment and access to these services. This allowed us to create a software product that has many of the advantages provided by the web-browser, but appears to the user as a normal Windows-based application. HTAs have been available since the introduction of Internet Explorer (IE) 5.0 and have been enhanced in successive versions. We developed SamePage client-side applications using HTAs that require IE version 6.0 or more recent.

In addition to the Unix-based server components and the HTA-based client applications, we used a variety of software tools to craft the SamePage system and environment. These included: (1) Macromedia Flash™ for creating animations and synchronizing audio; (2) Adobe Photoshop™ for manipulating and compressing graphic files; (3) Macromedia Dreamweaver™ for creating HTML source code; (4) IBServer (a Sourceforge project distributed under the GPL license) as a Windows™-based testing environment for the Unix-based server applications; and (5) Sapien's PrimalScript™ integrated development environment for Windows™ scripting languages.

Networking

SamePage is designed to run on a Transmission Control Protocol/Internet Protocol (TCP/IP) network. This could be a local area network (LAN) or a wide area network (WAN) similar to the Internet. Our technology approach assumes that standard versions of Unix-based server components [Apache (v1.3.28), Perl (v5.006), and PHP (v4.3.2)] would be available as part of the LAN or WAN. This provides a high-level compatibility with servers that might be available from typical WAN and Internet service providers (ISP). An organization that chooses to run SamePage over the LAN will be responsible for implementing and maintaining a Same-Page-compatible Unix-based server and components.

A primary challenge in a web-based application like SamePage is automated, reliable, and timely communication between the server and client applications. We used two techniques

remote scripting and XMLHTTPRequest object manipulation to address this challenge. Remote scripting involves embedded (within the client application) and hidden (from the team member) web browser windows that automatically (without team member intervention) exchange information between the SamePage client and server. The XMLHTTPRequest object allows asynchronous requests for server processing to be initiated through the HTTP protocol available in our HTA-based clients. A primary design consideration with either remote scripting or XMLHTTPRequest manipulations, is maintaining a reasonable level of CPU and memory utilization on the client. Our goal was to never disrupt the team member's computing environment or allow the SamePage user interface to feel sluggish. To collect data on the impact SamePage would have on a client computer, we conducted a series of tests with multiple embedded remote scripting windows and XMLHTTPRequest object calls.

During these tests, we attempted to bracket the timing constraints on sending and receiving message updates using a Web-based architecture. We generated representative loads within our HTA environment by incorporating SamePage-specific materials—maps, communication messages—into example displays. In the course of these tests we collected data showing that server response time in a shared hosting environment (hundreds of web sites served from a single computer) would likely not meet our precise timing and synchronization requirements. Subsequent tests conducted with two shared-hosting environments confirmed this tentative conclusion. Based on these results, we moved the SamePage client-server testbed to a virtual private server (VPS).

The VPS hosting environment has three distinct advantages over a shared hosting environment. First, only 20 – 30 web sites are served from a single computer with precise control over the resources used by any single web site. Second, a VPS allows the operators (in this case, us) control over the configuration of the web server allowing us to implement performance enhancements that would otherwise not be allowed. The third and final advantage is cost. The monthly charge for a current VPS account is $49.95 compared to $300.00 for a dedicated computer that would serve only our web site.

Once we were settled into the VPS environment we began our investigations of SamePage scenario event update rates. Within SamePage we have two types of events. The first (e.g., team member comms and email) should be very fast but not necessarily synchronized among all team members. The second (presentation of training materials) has to be precisely synchronized but not necessarily occur in rapid-fire succession. Because of this requirement we investigated running SamePage using two simultaneous update rates. The first would run at a one-second rate and update data that required fast response but not precise synchronization. The second controlled training "events" that require more precise synchronization and updated once every five seconds. Using the dual update rate implementation, we conducted tests using six computers connected to the Internet through a single router. This test set-up mimics a SamePage training session (five team members and one instructor/facilitator) conducted from a single location (e.g., a single room or building). The results showed that the dual update rate allowed successful SamePage communications without user-perceived delays in sending and receiving comms but there was some unsynchronized presentation of training materials at the five-second "training" update rate. This was due to multiple SamePage workstations competing for the limited bandwidth available from the single router.

We solved the synchronization issue by "pre-loading" large content assets (photos, audio files) at the beginning of a training module. Because these assets were then resident on the local machine's hard disk, they could be displayed on all team member displays in a timely manner based on a small synchronization signal from the server. The pre-loading of large video and audio files became part of the software setup procedures required for installation of the SamePage system at a remote training site.

Graphical User Interface

Design sessions were held during the project's early stages to establish a common understanding of the framework for the SamePage graphical user interface (GUI), discuss technical requirements, and begin the process of integrating training content with the delivery system–computer presentation over a network. In the project's first year, we went through a number of evolutions in interface design in tandem with our scenario development efforts. We knew from the outset that two different GUIs would be needed, one for team member workstations and one for the I/F. A main design goal was to create a common GUI for all five team members to simplify implementation and extension of SamePage to other content domains.

An early prototype of the team member GUI was composed of four main components: (1) Main Menu, (2) Situation Display, (3) Team Member Comms, and (4) SamePage Email. The Main Menu and Team Member Comms areas were continuously displayed and accessible at any time. The Situation Display and SamePage Email shared a common area and were accessed using mode buttons contained within the Main Menu. In addition to menu items and mode buttons, the Main Menu area contained a status display of scenario points and scenario time. The Situation Display displayed text and graphics and was accompanied by a chronological listing of content that the team member could access at any time the Situation Display is active. An example of an early Situation Display prototype is shown in Figure 10. The Team Member Comms area was intended to support short text messages between team members. Each team member could designate one or more recipients for each outgoing comm message. Incoming comm messages were displayed as a continuous stream that contained messages from all recipients. In this version of the GUI, SamePage Email provided a simple email-like application that allowed team members to exchange email-like messages with other team members as well as other entities that might be involved in the scenario. In essence, the incoming and outgoing "comms" were intended to simulate voice-based communications and the email was for exchange of documents and non-time-critical messages.

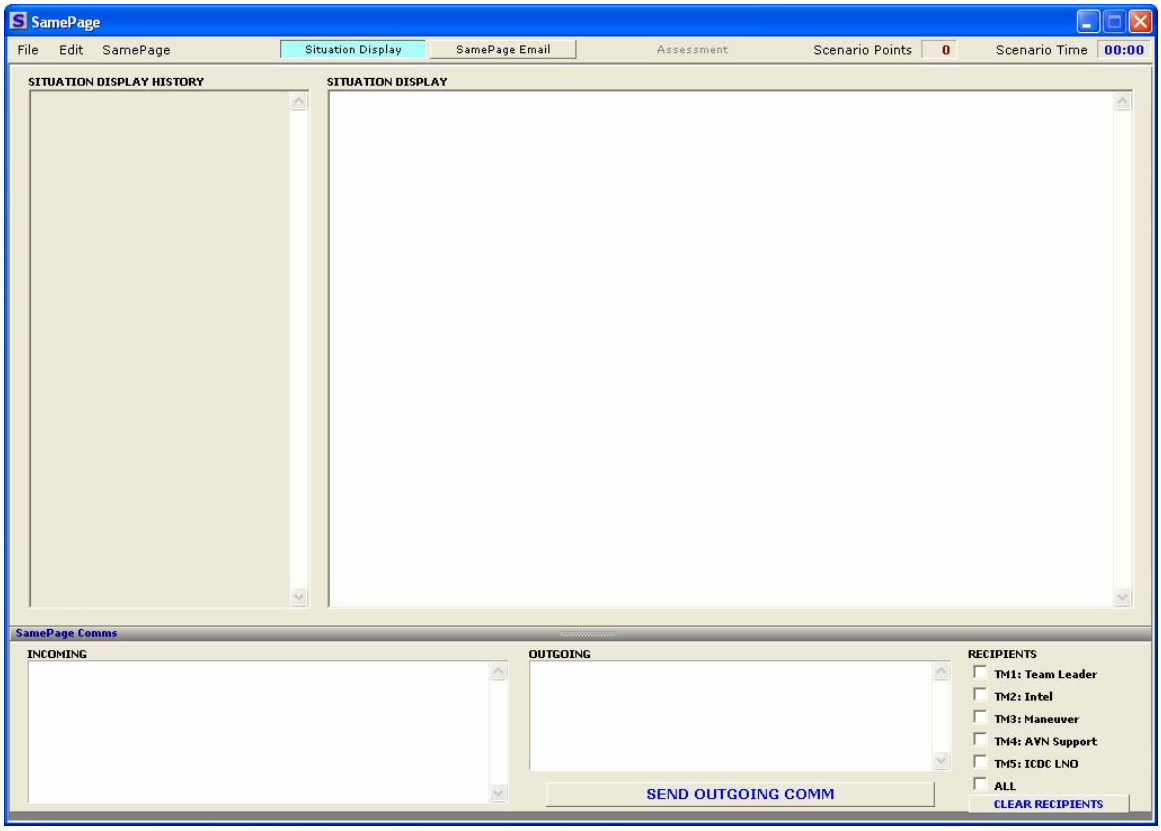

Figure 10. Example of an early SamePage GUI prototype.

Work continued with this same basic GUI concept for the first half of the project, where mockups were developed that provided functional demonstrations of the Situation Display and Team Member Comms components. As shown in Figure 11, these demonstrations also provided a saved history of previously transmitted documents to the user. These functional prototypes included implementing the features and functions required to transmit, receive, synchronize and track representative SamePage scenario content (maps, photos, text documents)—and served as the technological basis for future GUI versions.

Although initial work with the concept shown in Figure 11 was encouraging, we subsequently discovered that adding functionality to the display modes created confusion among test users. In particular, it was difficult to convey where and how the user was to interact with the screen content in order to annotate graphics, enter text, manipulate tables, and so forth. Accordingly, we modified the team member GUI to create a more “task-friendly” environment. To do this, we replaced the E-mail mode with a task workspace. The workspace included tabs to perform several customized activities, such as (1) creating a briefing slide, (2) making notes, (3) maintaining inventory lists, and (4) marking up situation display items.

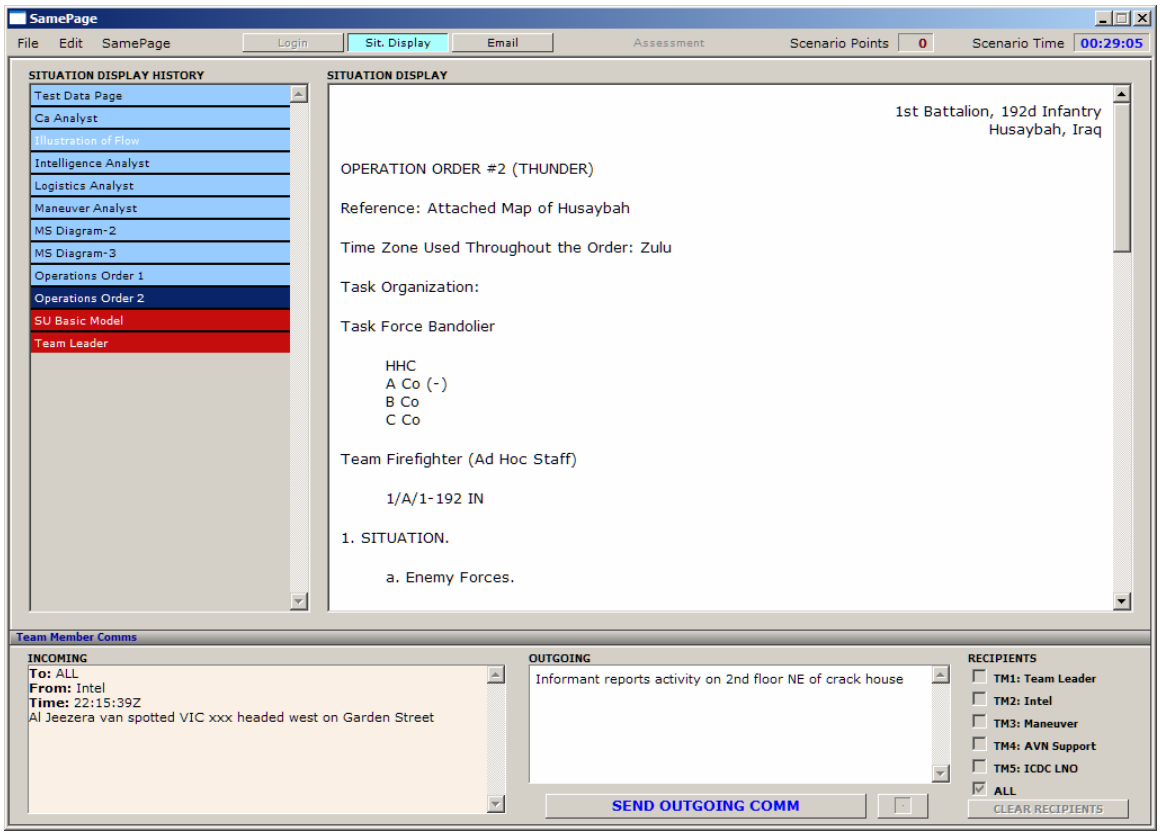

Figure 11. Example of early GUI concept illustrating document "history" display.

While the workspace mode concept was an advance, the multiple tabs and customized work activities proved difficult to implement and make discoverable to test users. We then came upon the idea of having a much simpler and "cleaner" interface concept in which three modes would be provided: (1) communications, (2) workspace, and (3) monitor. To this basic interface we also added two distinctive SamePage interface components. The first is a constantly visible "frame instruction" display that team members can use to track their current task. The second is a "task designator" that allows each team member to designate a short text description and state (e.g., ongoing, complete, deleted, on-hold, delegated, or shared) of their current task.

As part of the simpler, cleaner concept, we also explored and implemented the necessary functionality of the task monitor mode which allows each team member to view a display (updated every five seconds) of the tasks each other team member is engaged in. This functionality involves each client communicating its current task status to the server and the server then re-broadcasting this status to each of the currently active team member clients—all within five seconds. As well as current task status, the monitor mode also includes a graphic display of the tab (Communicator, Workspace, or Monitor) on which other team members are currently resident. This was done to mimic an "over the shoulder" observation style that would naturally occur if team members were physically co-located.

Figure 12 displays an example of this simpler, “new look” interface concept, where the Communicator tab is shown. In subsequent design efforts, we investigated methods for alerting the trainee of arriving attachments, completed the inter-team recipient list (i.e., the non-team entities being role-played by the I/F or scripted by SamePage), finalized placement and functioning of the Frame Instruction and Task Designator windows, and refined the features and functionality of the communications windows.

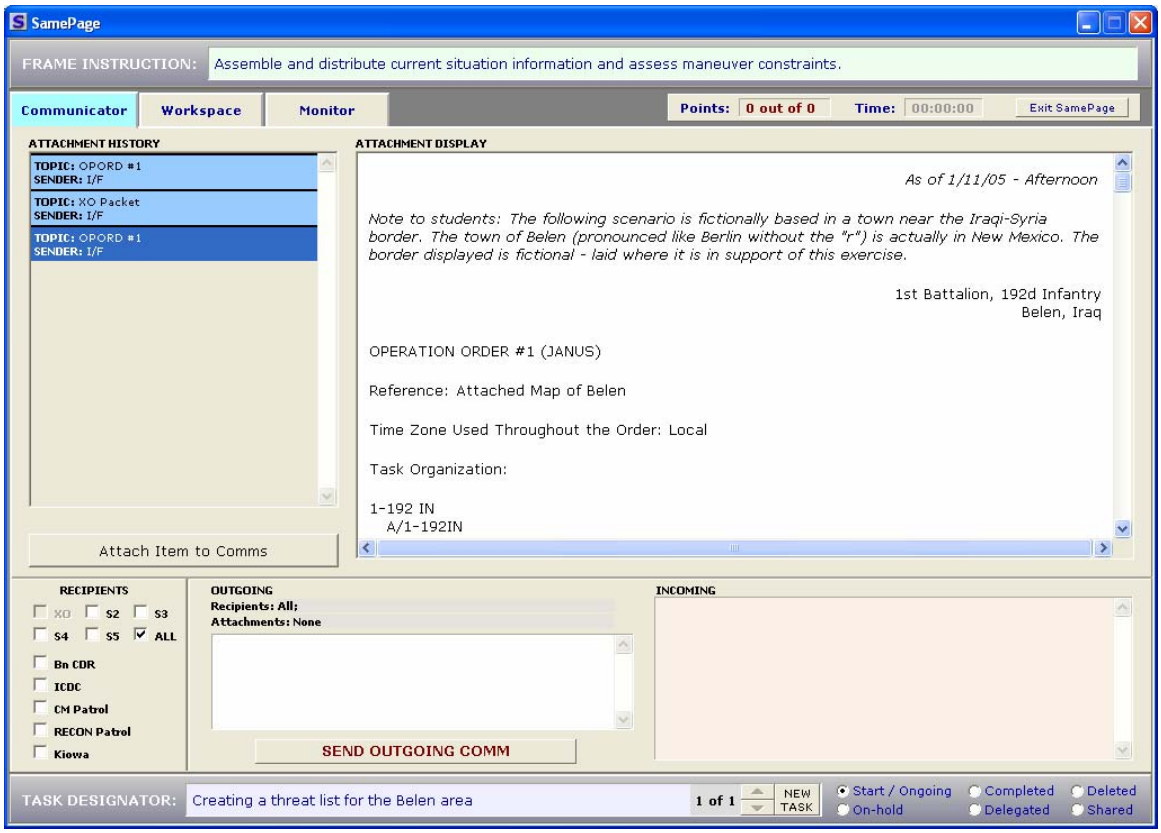

Figure 12. Example of the Communicator tab from the “new look” SamePage GUI.

In later efforts, we focused our attention on fleshing out the details of the Monitor mode. This mode provides the trainees with the necessary functionality to engage in the synchronization processes (monitor, communicate, intervene) that are the foundation of our training. We struggled with specifying how SamePage users would designate the “tasks” they are working on, the status of that task, and how this information would be conveyed within the Monitor Task interface. We were unable to fully resolve the final specification for this capability within the life of the Phase II project. As shown in Figure 12 (bottom-left corner), we currently allow input of a short text-based designation of the task and six possible states for the task: ongoing, on-hold, completed, delegated, deleted, and shared.

In the latter stages of the project, we continued work on the detailed aspects of GUI functionality and layout. This included the logic underlying the use of Instructional Frames and the Task Designator, constructing templates to serve as the basis for presenting the four main content types of the workspace (free text, tables, graphics, formatted reports), as well as the final communication requirements between client and server. This included a capability allowing a team member to send documents as attachments to a comms message. This capability is used to send documents (photos, maps, and text) between team members as well as submitting exercise responses to the I/F. In addition, we implemented highlighting and annotation capabilities in the Workspace mode. This allows the team member to highlight (in their own color) text in documents that are received or created and attached. The team member can also insert (with drag and drop) "callouts" (with edited text) that can be used to annotate either text or graphics.

In the several months leading up to the Los Alamitos technical demonstration, we addressed remaining functionality requirements that were distributed across the three main tabs (Communicator, Workspace, Monitor) of the interface. For example, we extended the software functionality to send and receive attachments of all content types and to move documents between tabs. We implemented the Assessment screen, which appears at the end of each frame. When the Assessment screen is active the main menus of the interface (Communicator, Workspace, Monitor) are removed so that the user can only enter information into the available response boxes. In addition, we implemented an "Advice" function that allows team members to received pre-determined suggestions on how they might proceed at different points in the scenario. This advice will be sent to the team member at pre-determined time intervals after the beginning of a frame. This requirement arose so that the scenarios could be completed by users who have limited experience in their designated team role.

As part of the final GUI implementation we also developed a shared document capability. This capability allows a team member to edit a document that can be viewed by all members of the team. The current implementation uses this facility to share threat lists and lists of friendly forces. A shared/common listing of friendly and threat forces is accessed in the Workspace tab. When clicking the appropriate button, the user will see a list of friendly forces that are presently located within the scenario. By clicking the Add or Edit button, the user has the ability to add or make changes to the table based on information they presently possess. The document is "shared" since only one team member can change the table at a time, although all team members can continuously view the table. An example of shared document capability is shown in Figure 13. If a team member wishes to work on the table but it is in use by someone else, a dialogue box appears informing them that they have to wait until the table is free. This capability is one of the ways that we teach users how to work together and stay in synch in order to create a coherent mental picture of their training scenario.

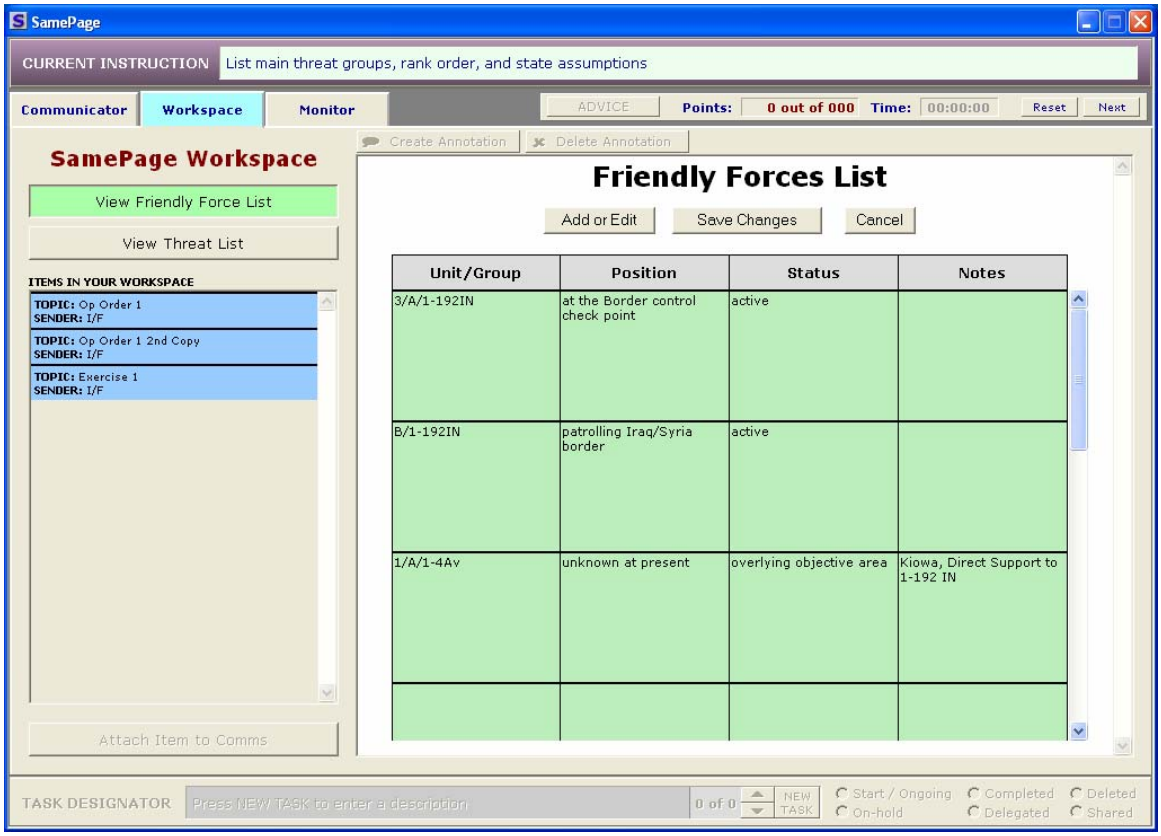

Figure 13. Illustration of the document-sharing feature available in the Friendly Forces list.

A common, though much abbreviated, development path was followed for the I/F interface. Because much of the required I/F GUI functionality was shared with the team member interface, we used the team member GUI as the foundational basis. Consequently, development of I/F-specific functionality was initiated much later in the project. The I/F's need to monitor and pace a session required the addition of some unique functionality regarding the timing and control of scenario events. We adopted a "timeline" metaphor that allows scenario events to be selected and initiated. The timeline allows the I/F to control the initiation of automated or timed events as well as discretionary events that might be used to respond to event-specific team member actions or comms. The timeline allows starting, pausing and repeating of the events that comprise a SamePage scenario. Because the I/F role-plays so many different entities, we also expanded the I/F's communications window since he/she needs to be able to see the incoming communications from all the team members.

SAMEPAGE TRAINING SYSTEM

This section briefly describes the content, format, layout, and logic underlying each of the four blocks of SamePage instruction. Since the training materials are readily available in dynamic form on the web, this section will present only select graphics to illustrate key points and give the reader a flavor for the type of training that has been developed. In addition to the four blocks of training, SamePage instruction also involves some other activities, such as reviewing OPORDs, studying maps, watching a video (to learn about the interface), and practicing the roundtable discussion. These activities will be discussed where appropriate in the following subsections, where their supporting materials are also available on the web.

Block 1: Practical Concepts

The initial block of instruction is intended to give the trainee an overview of shared understanding as a practical concept that can be applied to enhance the performance of *any* team for which they are a member. This block is fairly short, and is designed for completion in about 30 minutes. Most of the verbal information is provided in the form of a voice-over, in which a prepared script was read by a professional actor. The use of a verbal narrative, coupled with limited text and supporting graphics and animation, has been found to be an effective method for presenting an instructional narrative (Mayer, 2001). We follow that model throughout Block 1, and much of Block 2. Expecting students to read large blocks of text on the screen is simply not an effective instructional method.

Components and Dimensions of SU

The instruction begins by likening shared understanding (SU) to mishandled information. Actual Army photos are interspersed with graphical information describing the types of training to be provided and the basic elements of SU. Examples of poor and good SU are then given, in which two tactical messages are presented that describe the actions of a group of insurgents. The two messages, one poorly constructed and the other well-designed to promote SU, reference a map of downtown Belen, Iraq (Figure 14). This map used for the tactical scenarios of Blocks 3 and 4. Though unstated, one of the instructional goals of both Blocks 1 and 2 is to give students familiarity with the tactical setting and cultural background of the region they will be operating from in the mission scenarios of Blocks 3-4. After each message, students are asked to answer a number of questions regarding the location, direction of movement, and description of the insurgents.

The training then shifts to a description of the “what” of SU, covering first the Situation-Mission-Team distinction. Then, the 18 dimensions of SU are presented in the form of a synchronization cue card (Figure 15). Throughout the explanation, students are asked to keep in mind the distinction between relevant (shareable) and irrelevant information. Next, students are asked to participate in a role-playing exercise, in which they review the OPORD, the Belen map, and team member roles and responsibilities information from the perspective of the S-5 (civil affairs).

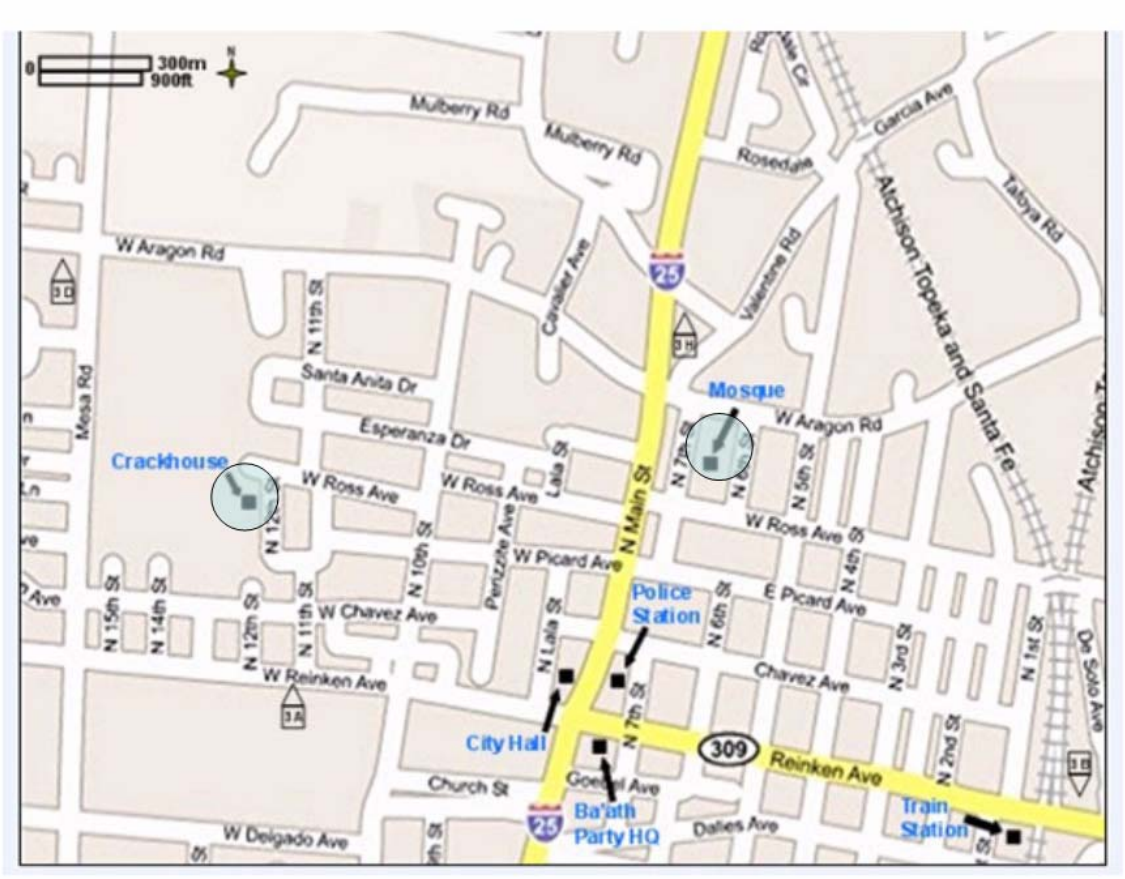

Figure 14. Map of downtown Belen, Iraq, used in the mission scenarios.

Synchronization Processes

Block 1 instruction then transitions to the three synchronization processes (monitoring, communication, intervention) of SU. The voice-over describes how these processes contribute to SU in the context of a flow graphic. As part of this instruction, students are presented two additional cue cards, one covering the signs of SU present and the other the signs of SU breakdown. Trainees have time to study each cue card.

Self-Study Modules

At the conclusion of the training block, students are given an optional link to review additional material—the more extensive descriptions of SU concepts, dimensions, and processes that were developed in Word files. These materials appear as four independently accessible modules. The first covers the basics of SU, including some of the theoretical underpinnings that were discussed in the beginning of this report. The second and third modules describe the components and dimensions of SU, respectively, in some detail. The fourth module discusses the conceptual foundations behind the three synchronization processes and how they can be used

together to promote, maintain, or restore SU. Questions are embedded within each module as a check for the reader to gauge his/her understanding of the material. If desired, the modules could be used by the I/F to quiz their trainees or as self-study material.

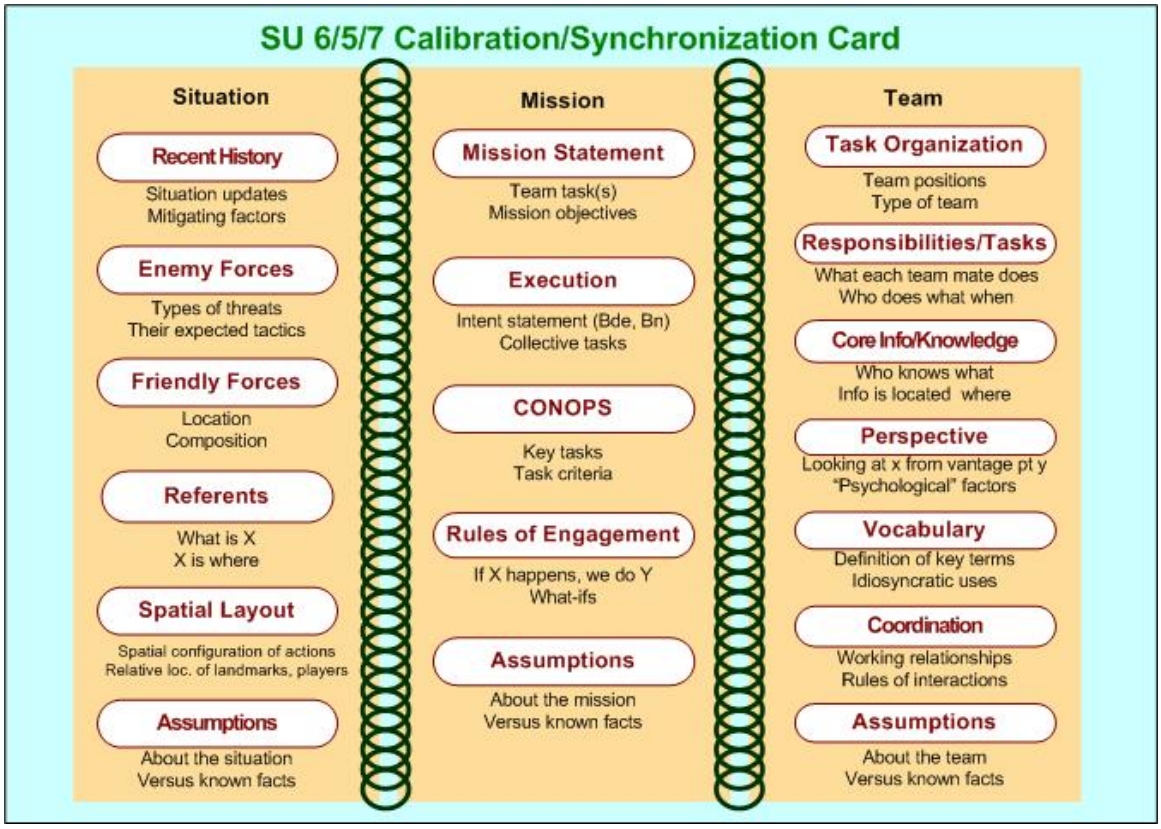

Figure 15. Synchronization card listing dimensions of SU.

Block 2: Nine Methods of Developing Shared Understanding

Individual Instruction

The student accesses Block 2 by clicking on the corresponding link on the SamePage splash page. The instruction covers nine methods for promoting, maintaining, and/or reestablishing SU. The first part of the training covers the use of five of these methods for situations where there are "right and wrong answers." These are the methods that were identified by our Army experts at Fort Carson, and include:

- Asking critical, focused questions
- Engaging in table-top exercises and "what-if's"
- Providing feedback to an individual team member or group
- Giving a back-brief on something just heard or learned
- Tailoring a message for a designated receiver

These methods are covered in the context of an extended example in which an infantry company commander asks his lieutenant to formulate a plan to divide his platoon into an inner cordon and an outer cordon in order to locate possible insurgents. The action takes place in the Belen, Iraq area of operations (AOR). The outer cordon forces provide outward-looking security while the inner cordon forces utilize force to "take down" a building should that prove necessary. These tactics are part of the action that occurs in the tactical scenarios, so familiarizing the students with them here is intended to facilitate learning once they get to Block 3.

The instruction provides several voice-overs that (a) first provide the company commander's guidance and intent and then (b) the lieutenant's plan to adhere to that intent. It uses maps to outline the flow of action and then presents, in text form, some questions the students are to answer concerning the quality of the lieutenant's back-brief to the company commander. The students are shown the lieutenant's back-brief in written form, and then use drag-and-drop to place selected parts of the text into two boxes: a bin for items that are consistent with the company commander's original guidance and a bin for those items that are not consistent. Block 2 then provides instruction in the proper method for providing feedback to the lieutenant so that he and the company commander are "on the same page. "

The other technique, what-iffing, is covered by continuing the example. Here, the lieutenant is now meeting with his platoon, where he briefs the sergeant on the requirements for the inner and outer cordon tactics. The lieutenant uses several what-if's to see how the sergeant will respond. In this case, the sergeant uses a satellite photo of the area where the cordons are to be established. This is similar to the photos they will be seeing during the tactical scenarios. The training shows where, on the photo, he would place his troops to be consistent with the lieutenant's guidance. A copy of the photo is shown in Figure 16; the red dots show the outlines of where the sergeant would position his troops.

The student then hears a voice-over explanation of the sergeant's planned tactics. Following that, the student sees a text display of three possible responses (by the lieutenant) to the sergeant's plan. The student is to pick the one that provides the most effective feedback and resulting SU between the two Soldiers. The instruction provides feedback concerning the strengths and weaknesses of each response.

Blended Instruction

The remaining four methods involve promoting, maintaining, and reestablishing SU when "there are no right and wrong answers." These are the methods that were extracted from the R&D literature during Phase I. Because they require the participation of groups of students, they require a "blended" learning environment in which students work some of the time on their own with a computer, and some of the time they meet in groups. The methods are:

- Create and Share Organized Lists/Vetting & Resolving Items
- List and Diagram Relationships of Situation, Mission, or Team Elements
- List and Compare Core Information/Knowledge, Tasks/Responsibilities
- Team Visualization or Looking Ahead

Figure 16. Satellite photo of downtown Belen, Iraq.

Three parts exist for the “Create and share lists,” “Compare core information,” and “Team visualization” methods:

- Each user interacts individually with the computer to solve an analytical problem.
- Each user interacts with a teammate’s analysis.
- The team gathers to discuss the analytical problem.

The general nature of this approach can be illustrated by describing the method, "Create & Share Organized Lists/Vetting & Resolving Items." Users are asked to login with their team member assignment. This login tags the totality of each analysis with the appropriate position identifier (e.g., S3). After logging in, the user is presented with an analytical problem. In this case, he or she must list the factors associated with the location of US Forces – close to the populace as opposed to remote from the populace (see Figure 17).

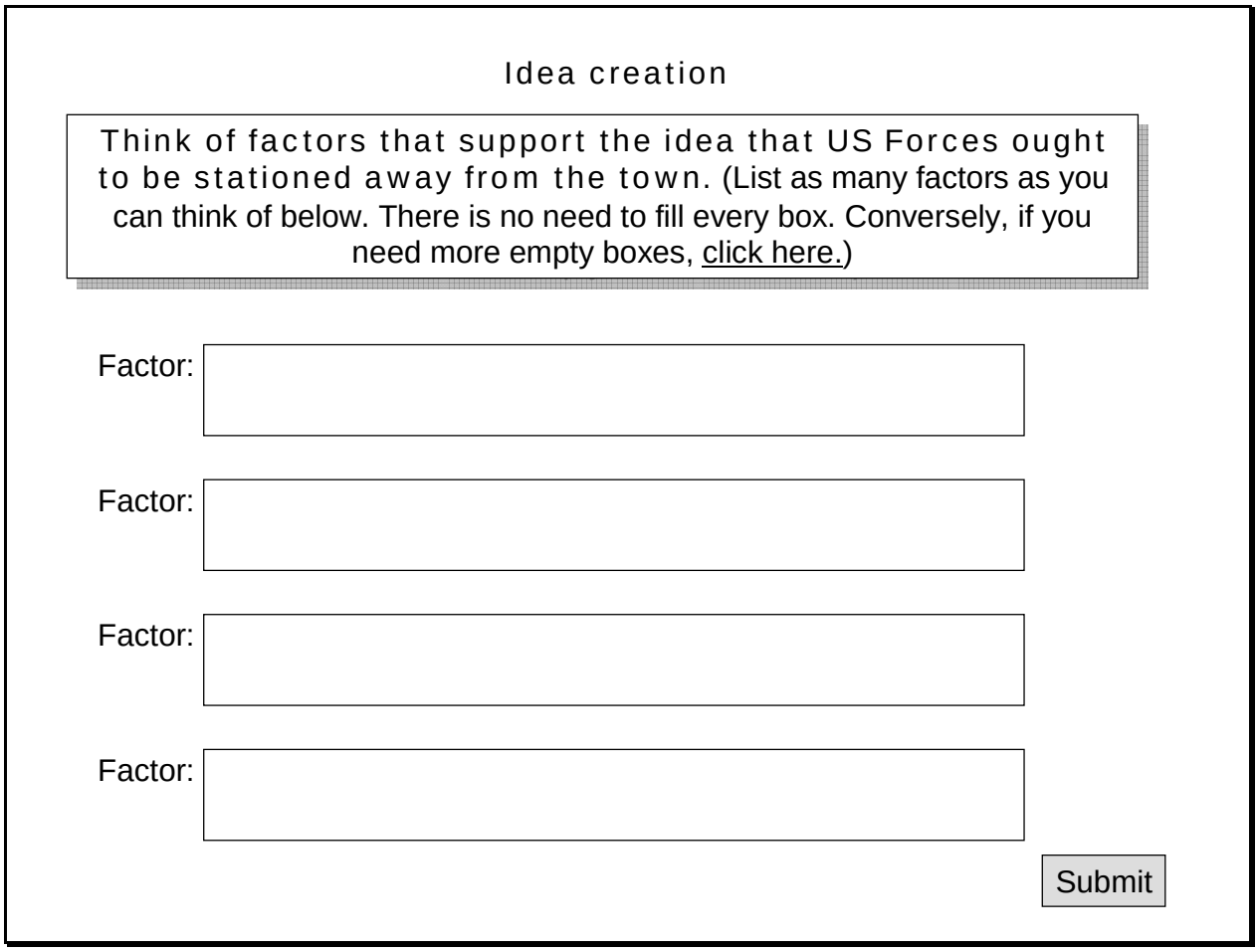

Figure 17. Analytic problem screen.

The user submits his/her compiled list to the central database. When all users have submitted their lists, the user receives the full compilation of that list and acts on it as described in Figure 18.

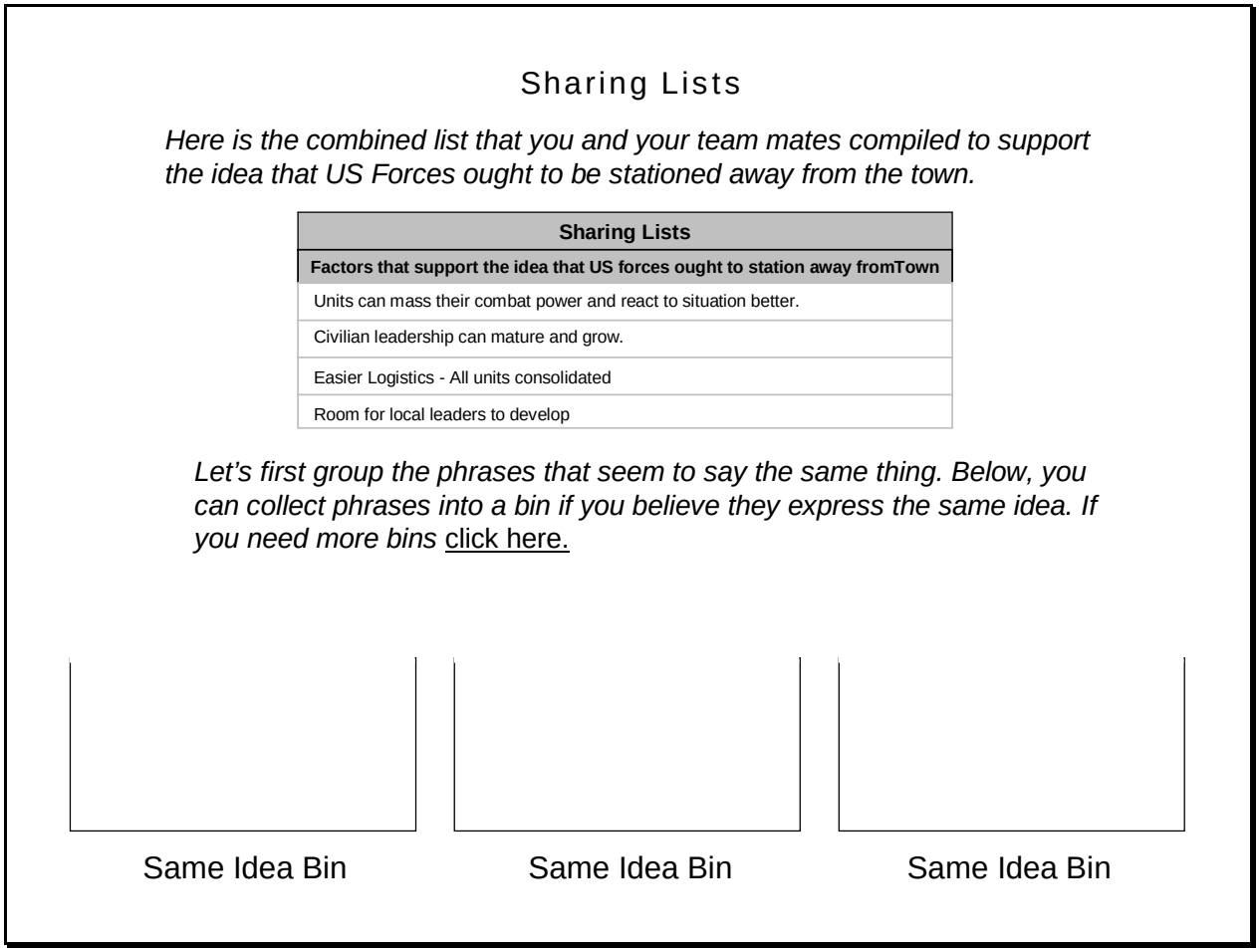

Figure 18. Bins for sharing lists.

Now the user is prepared to critique the work of teammates and, ultimately, gather to resolve the various analyses into a coherent group whole. This process of individual work intermittently integrated into group activities is illustrated in Figure 19.

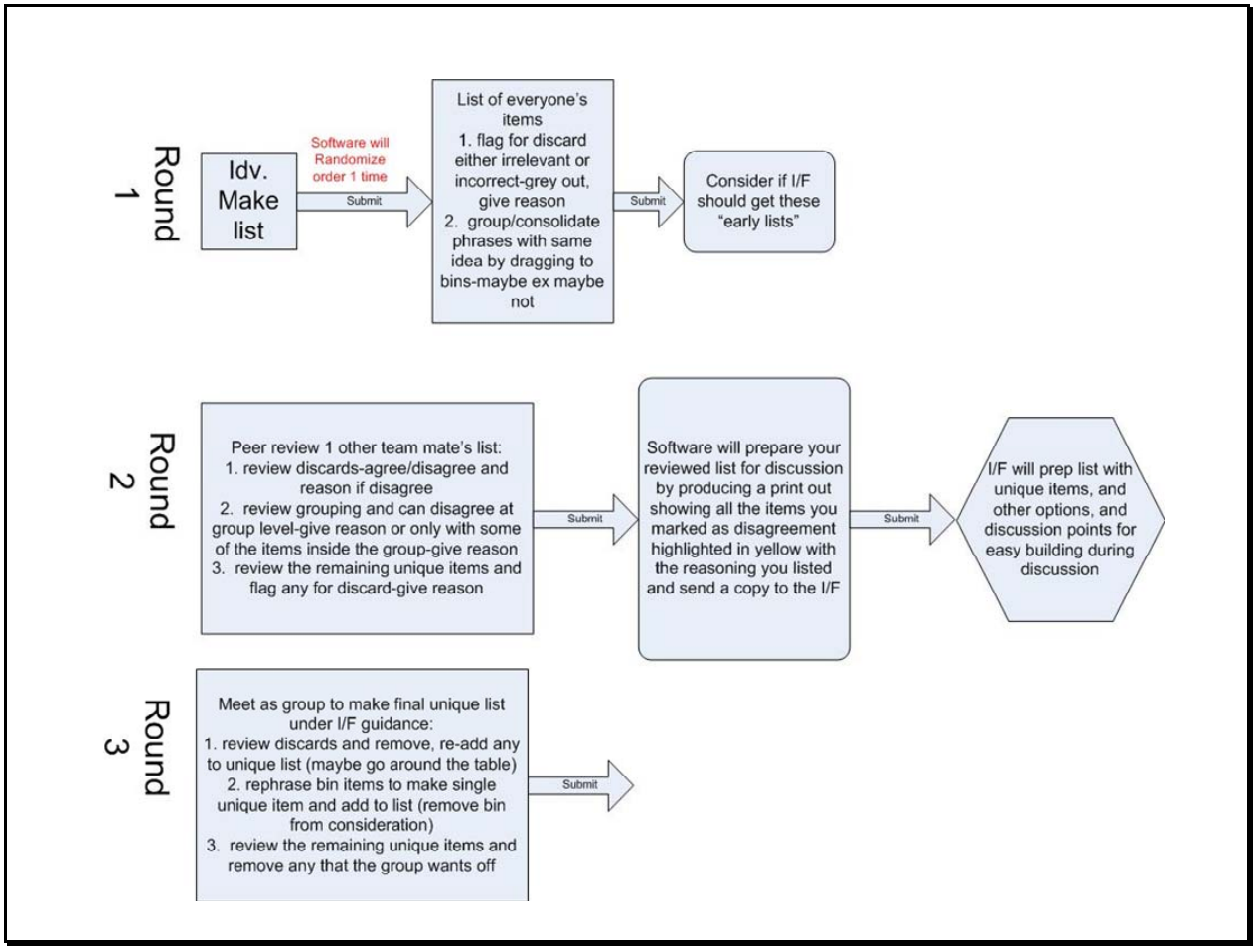

Figure 19. Process for critiquing team members.

Self-Study Modules

As with Block 1, there are optional self-study modules that can be assigned by the I/F for his/her students. Each SU method comes with its own module. The modules are fairly short, about two to three pages long. They begin with a brief description of the method and why it is important for SU. A fairly detailed description of the steps required to perform the method is then given. Most modules end with a checklist that can be used by the trainee to help him/her apply the method in a practical context.

Block 3: Tactical Scenario Part I

A detailed description of the tactical mission scenario for Blocks 3 and 4 is provided in the Instructor's Guidebook for SamePage (Holder, et al., 2006). This document is available as a link from the SamePage web site. As discussed in that document, the scenario-based training in Blocks 3-4 must be conducted under the guidance of one, and preferably two, instructor/facilitators (I/F). The most effective way to experience the scenario is to access the SamePage "splash" page, click on the Team training link, and follow the directions. However, in the following section, we provide some basic descriptive information for the scenario. In particular, we describe: the trainee prerequisites before beginning Block 3, supporting materials, main tasks of the I/F, and synopses of the action that occurs in each of the eight frames. We close by outlining the measures of SU that are taken.

Prerequisites

The I/F will have the responsibility to ensure that training participants are prepared to receive the SamePage training. Before starting Block 3, each training participant should have:

- completed Blocks 1 and 2
- watched the 5-minute SamePage interface instruction video
- reviewed a 5-page operations order (OPORD)
- briefly reviewed the Belen area of operations map
- reviewed their respective team member roles
- reviewed the FRAGO to understand the current mission

Supporting Materials

While the computer presentation of the scenarios is the focal point of both Blocks 3 and 4, effective training in shared understanding requires that a host of materials be collected, organized, packaged, and delivered to the trainees. The I/F Guidebook documents this process in detail. Table 2 provides a brief description of each of the materials that are necessary to support effective SamePage training.

The materials listed Table 1 are all used or viewed by trainees at some point during the training. In addition, there are several tools that are used by the I/F to ensure that SamePage training proceeds smoothly. The tools are described thoroughly in the I/F Guidebook. Briefly, they include: (1) a scenario narrative the describes the entire scenario events in an overview story form; (2) an overview flowchart that shows the major frame events and actions required from each team member; (3) specific SU probes for each frame; (4) the topic and suggested answers for the roundtable discussion; (5) a table listing "important scientist moments," which lists the time, issue, and what to watch out for; (6) a timeline that lists the communications and attachments in the order they will be delivered; and (7) the friendly and threat lists (of status and location) for each frame.

Table 1
Materials Required to Support SamePage Training

Supporting Material	Description
SamePage interface instruction video	This 4-minute video is loaded onto each trainee's workstation via CD. It walks the trainee, step by step, through each aspect of the interface, including the three modes (communicator, workspace, monitor), the e-mail format, sending and viewing attachments, viewing advice, prompts, and accessing shared tables.
OPORD (Appendix A)	This 5-page document describes the task organization, situation, mission, execution, concept of operation, and rules of engagement for events leading up to the scenario. It includes several maps of Belen as attachments.
Maps of Belen (Figure 14)	Participants must have some working familiarity with the Belen area of operations to have success in the scenarios. We offer three presentations: (1) a topographical map of the Belen area, including the border control checkpoint; (2) a wide-view map of the Belen area, including the Basecamp Tiger from which logistics are provided; and (3) a map of downtown Belen, where the bulk of the scenario action takes place.
FRAGO	The fragmentary order is a one-page update to the OPORD, describing the events immediately preceding the start of Block 3. It specifically calls out information germane to each of the team members.
Team member roles (Figure 20)	Because SamePage training does not require that participants be experts in their assigned roles, we provide some "cheat sheets" to help them with their duties. More extended versions, one page for each team member, are also provided.
SU job cards	A packet of four, laminated taken-away SU job cards is provided for use at the roundtable. These include (1) the 6/5/7 Calibration/Synchronization card that lists SU components and dimensions; (2) SU-Development methods card; (3) Cycle of SU synchronization processes card; and (4) Signs of SU presence and Signs of SU breakdown card.
Laminated roundtable map (Figure 21)	A large map of the operational area of Belen can be printed from "lablemapscale(feet).jpg" on the SamePage CD. Lamination is recommended so that it can be used with a dry erase marker. The map can then be populated with movable 3-D objects (e.g., Monopoly pieces) to support discussions of tactical actions during the roundtable discussions.
Recipients List (Figure 22)	This lists, as a reminder to the trainees, the 9 non-team entities that might be contacted during the scenario using the e-mail communications capability of SamePage.

Team Member Specialties

XO: Executive Officer -Battalion

- 2nd in command under the Commanding Officer (Bn Cmdr)
- Keeps CO informed of events (gets team inputs, SITREP)
- Coordinates efforts among staff (info & timelines)
- Knows who can make what decisions

S-2: Intelligence Analyst

- Evaluates info to deduce, infer and compile information base concerning threats
- Source of high-quality actionable information for Team members
- Uses information to make predictions of enemy behavior
- Should be updated with relevant information

S-3: Maneuver Analyst

- Coordinates and positions friendly troops
- Is the contact for **military** non-team members Kiowa, 2 PLT, 1 PLT, etc.)

S-4: Logistics Analyst

- Ensures that troops have supplies (present/future)
- Evaluates roads and access options and variables (safety/capability/trafficability)

S-5: Civil Affairs Analyst

- Gathers info on local civic and religious leadership
- Is the contact for civilian non-team members (ICDC, mayor, etc)

Figure 20. Team member specialties for the five-person team in SamePage.

Figure 21. Profile view of the laminated map.

Recipients List

This is a list of the non-team member persons you can send, or receive comms (and attachments) to or from. In the interface your team members are listed at the top and you are highlighted in blue.

I/F is the instructor facilitator
Bn CDR is the Battalion Commander
1 PLT is 1st platoon, 1/A/1-192IN
2 PLT is 2nd platoon, 2/A/1-192IN
Kiowa is the Kiowa helicopter, 1/A/1-4Avn
BDE stands for Brigade and can include anyone at the Brigade level (BDE CO, XO, UAV controller, etc).
ICDC is the Iraqi Civil Defense Corps
DHD is a Disabled HMMWV detachment
HHC stands for HQ and HQ Company and will be used to communicate with other battalion assets such as the motor pool or a convoy

Figure 22. List of role-played entities that may be contacted during the scenario.

I/F Tasks

Because there is much for the I/F to do to run the scenario, it is recommended that SamePage training be conducted with two I/Fs, one to interact as part of the scenario (i.e., fictitious characters, field questions, keep scenario moving) and one to monitor the teams' communications, looking for examples of good and poor SU to bring up in the roundtable sessions. Collectively, the main tasks of the I/F will be:

1. During the interface interaction, play role of fictitious characters (Bn CDR, Kiowa, 2 PLT, 1 PLT, etc.) to send contingent communications, and, as needed, to send and answer comms to keep the scenario moving.
2. During the interface interaction, field questions to the I/F to keep scenario moving.
3. During the interface interaction, pause action as needed if technical problems or participants are overwhelmed (especially in the first couple frames when they are still learning the interface)
4. During the interface interaction, monitor interactions to take note of good/poor SU examples and how to best discuss those in the roundtable sessions.
5. Collect and assimilate the input from the selected ratings and probes for roundtable discussion
6. During the roundtable, sometimes you will lead the discussion, sometimes you will only suggest the topic to structure discussion, and sometimes you will just observe and point out SU issues (using the job cards whenever possible). As a general rule you will become more hands-off as you progress to the later frames.
7. Complete assessments of the team's current level of SU, during both the interface interaction and roundtable sessions.

Scenario Frame Synopses

The I/F Guidebook contains extensive descriptions of the events that occur within each frame. Some of the events are programmed into the SamePage computer, and occur automatically on the basis of time into the scenario. Other events are based on responses that are made by the team member participants, and are thus "contingent" events. In Table 2, we provide summaries of the actions that occur in each of the eight frames of Block 3.

Measures of SU

A common sequence of events is used to measure SU in each frame. First, once the scenario pauses, participants are shown a team self-assessment, behaviorally anchored rating scale through the interface. They are asked to rate their team's present "state" of SU on a five-point scale (Figure 23). At the same time, one of the I/F-observers also rates the team's SU state using this scale. As a third measure, the participants receive an SU probe through the interface asking them specific questions about the events that just transpired in that frame. These probes are specific and vary widely across frames. A list of the probes used in Block 3 is shown in Table 4. The participants then engage in the roundtable discussion concerning the just-completed scenario frame. At the end of the discussion, the observer then makes a second rating of the team's SU state using the five-point scale depicted in Figure 23. The measurement concludes by asking the participants to complete a "look ahead" probe, which asks them to make predictions about upcoming events. These probes are also frame-specific. These look-ahead probes appear as the bottom entry in each right-hand cell of Table 3.

Block 4: Tactical Scenario Part II

Frame 9 is the first frame of Block 4, where the participants continue the scenario but are given minimal guidance, feedback and assessment probes. The I/F's main concern will be to unobtrusively note SU issues and examples, and only intervene enough to keep the scenario progressing. Before starting Frame 9, participants will be told that they are now in Block 4 and that the I/F will largely be hands-off, allowing them to practice SU and decide what should be discussed, communicated, and how. When ready to begin Frame 9, the I/F confirms (either verbally or through the interface) that all the participants are ready to start; he/she then starts the action. It will likely take some trial-and-error to find the right mix of assistance and structure to run the scenario during the initial frames of Block 4.

The I/F Guidebook also contains extensive descriptions of the events that occur within each frame of this block of training. As before, some of the events are pre-programmed while others are "contingent" on the actions of the participants. In Table 4, we provide brief summaries of the actions that occur in each of the eight frames of Block 4.

In Block 4, only three measures of SU are taken each frame. Once again, after the scenario pauses, participants rate their own team's SU. The observer makes a similar rating. After completing the roundtable discussion, the observer makes a second rating of the team's SU state.

Table 2
Synopses of the Eight Frames in Block 3

Frame	Synopsis
1	The action begins with the spotting of some hostages being escorted along Ross Avenue. The main events of Frame 1 revolve around determining the current location of the hostages, likely destinations, and orchestrating a response with the troops on the ground.
2	The main events of Frame 2 revolve around 2nd Platoon's disabled HMMWV, leaving a 6-man disabled HMMWV detachment (DHD) with the disabled HMMWV, the rest of 2 PLT pushing on toward the Crackhouse, coordinating the ICDC patrol to support the DHD, and the Kiowa entering the picture.
3	There are two main event themes in Frame 3. The first is the DHD, where the coordination of the DHD is turned over from the S-3 to the S-4, with the convoy ETD at 2 minutes, as the ICDC heads towards the DHD as well (they will meet in Frame 4). The second theme is gun positions on the roof of the Crackhouse, which the Kiowa should scout out to determine they are unmanned before returning to base due to low fuel.
4	There are several main events that take place in the 4 minutes of Frame 4. The main event is the meeting of the ICDC and DHD and whether it is coordinated safely or results in a fratricide. The second is 1st Platoon reporting in and becoming involved in the CH operations. These main events are accompanied by signs of danger to come, such as the report of ambulances by Kiowa 1 on their way back to Basecamp Tiger (these will play a larger role in upcoming frames), and the informant report of abandoned streets around the CH (a sign of trouble).
5	There are several main events that take place in Frame 5. At the Crackhouse, armed insurgents are seen by 1 PLT and an RPG (rocket propelled grenade) spotted by the Kiowa on the rooftop one building to the south, causing the ground troops to hold at a distance. In convoy operations, the wrecker convoy has additional ambulance sightings, the DHD is getting restless and a UAV from BDE will make a sweep of the convoy route.
6	There are several main events that take place in the Frame 6. At the Crackhouse, 2 PLT and the Kiowa are given a daring RPG elimination plan and 1 & 2 PLT get a task organization and inner cordon plan to enact when the RPG is gone. In convoy operations, suspicious ambulances are seen near the Belen Arches and by the DHD. When the ICDC patrol attempts to pull over the ambulance, it flees and gets away. The wrecker convoy is making slow progress due to a traffic jam (that will later reveal itself to be part of a roadblock ambush trap).
7	The action is spread across several locations in Frame 7 but with three main event themes. The first is mortars landing around 2 PLT and originating from near the DHD location. The S-2, S-3, S-4, S-5 are all involved in determining the location, and sending a small detachment of ICDC and 2 PLT personnel from the DHD in pursuit. The second main event theme is the ICDC LNO spotting an Al Jazeera (media) van heading north up Main street, possibly toward the DHD or the Crackhouse. The 3rd main event theme is the wrecker convoy operation, which reports in at 1 Km north of the arches (and will reach the roadblock trap in the next frame).
8	The action is spread across several locations in Frame 8 but with four main events. The first is the convoy reporting seeing the ICDC patrol at a roadblock above the arches which is waving them in (this is a trap by the bad guys). The team has to identify it as a trap before 02:30 when the convoy retreats. The second is when the Al Jazeera van turns west onto Picard, heading toward the Crackhouse. The team needs to figure out its destination and alert the 2 PLT outer cordon to stop it. The third is the inner cordon moving into place, surrounding the Crackhouse. The last is the Kiowa reporting that it needs to return to base, leaving the team with no eye in the sky.

1	2	3	4	5
○	○	○	○	○
-Mass comm confusion -Little or no monitoring -No task backup	-Many not responded to -No one individual monitoring everything -Little help with tasks provided	-Team synch goes in and out -Have pockets of good team flow -Some TMs more in synch than others	-Most TMs in synch most of the time -Only a few comms are confused -Most TMs tasks backed up	-All TMs in synch -All comms make sense -All tasks backed up

Figure 23. Five-point SU rating scale used for team self assessment and observer assessment.

Table 3
SU Probes used in Block 3

Frame	SU Probes
1	• Where do you think the kidnappers (and hostages) are heading? • Rate your confidence in that location on the 1-5 scale below. • List 2 other possible destinations for the kidnappers. • Look-ahead: fill in a table listing 3 persons/groups other than the Bn staff (XO, S2-S5) that might get involved in the upcoming frames and the role they might play.
2	• List 3 items of information that he/she could contribute to a group SitRep for the Battalion Commander. • Look-ahead: briefly describe the expected kidnapper response/tactics if cornered.
3	• Fill in a blank Threat list table with as much detail as you can. • Look-ahead: In the table below list the major roles and responsibilities (or tasks) for each team member in the next frame. Check their answers to see if there is 5/5 agreement that S-4 is coordinating the DHD which is typically an S-3 task.
4	• What are the possible connotations of the ambulance sightings? • What are the possible connotations of the abandoned streets around the Crackhouse? • Look-ahead: Briefly describe the roles that the ambulances might play in upcoming frames.
5	• List the current threats. • Rank them on immediacy with 1 being the most immediate threat up to 5, or however many threats you list being the least immediate. • Note any assumptions that these assessments rely upon. • Look-ahead: List 3 pieces of current intel that are based on assumptions.
6	• What are your ROEs for ambulances? • Look-ahead: List 3 ways the RPG plan could possibly go wrong.
7	• In the table below list 3 pieces of information you could contribute to a discussion of the kidnappers' intentions: DEAL expect to trade hostages for something NEUTRAL SUICIDE MISSION with high publicity hostage kill • Look-ahead: Where do you think the Al Jazeera (AJ) van is heading? Rate your confidence in that location on the 1-5 scale below. List 2 other possible destinations for the Al Jazeera (AJ) Van.
8	• Ask each participant to list 3 items of information that he/she could contribute to a group SitRep for the Battalion Commander. • Look-ahead: In the table below list 3 persons/groups that the kidnappers might be communicating with on the cellular phone. For each person/group, list an indicator you might see in upcoming frames that would indicate this was in fact the person/group.

Table 4
Synopses of the Eight Frames in Block 4

Frame	Synopsis
9	The action is spread across several locations in Frame 9, but with three main event themes. The first event theme is the Al Jazeera van is detained by the 2 PLT outer cordon Group 2. Its occupants do not speak English, requiring identification and relocation of a translator from Group 1 to interpret. The second event theme is the response to engage the fake position, planned by the Bn CDR and utilizing 2 squads from 1 PLT. This requires a task reorganization affecting almost all of the friendly forces (including Kiowa 1) and most of the team. The third event theme is the ICDC LNO providing the blueprints to the Crackhouse. The S-5 will have to disperse these blueprints to the team for assessment and the ground troops for planning.
10	The action is spread across several locations in Frame 10, with three main event themes. The first event theme is the Al Jazeera van occupants begin to protest civil liberties violations. The Bn CDR says 2 PLT can do what they want as long as AJ get no closer to CH. Meanwhile, the ICDC LNO advises a delicate response, and an interpreter arrives from 2 PLT outer cordon group 1. The second event theme is the fake position plan, where 1 PLT reports in about half way there, the Kiowa is enroute, and the wrecker convoy is briefed and ready. The third event theme is the mosque blaring a transmission in Arabic, although it is not prayer time. This broadcast can be heard all the way up at the fake positions. Specialist James is translating it, which will prove in the next frame to be the US troop positions and inside information about 2 PLT obtaining the CH blueprints.
11	The action is spread across several locations in Frame 11, with three main event themes. The first event theme is the Crackhouse operation, where the Al Jazeera van is released under orders to stay away or be arrested. Some locals are seen on Mesa road to the west of the Crackhouse, resulting in one HMMWV from the Farmhouse responding to disperse them. Also, a ladder was found to reach the CH 2nd floor--although the plans may be compromised (see mosque events), and the kidnappers are seen on the phone again. The second event theme is the mosque broadcast is interpreted to be giving away US troop positions as well as other intel, such as 2 PLT having the CH blueprints. This, in turn, adds concerns of a larger controlling element, and the need to determine how to respond to the mosque as a threat (which is tricky). The third event them is the fake position plan, where the insurgents scatter after hearing the mosque broadcast. They go mostly to the south (toward the mosque). Meanwhile, 1 PLT captures 1 prisoner, and directs the convoy to reconvene at the DHD, as the Kiowa tracks the insurgents who are fleeing.
12	The action is spread across several locations in Frame 12, with three main event themes. The first event theme is the Crackhouse operation, where the kidnappers have just issued their demands to release Riyadh Khaled Hakeem, a known smuggler, cousin of the Imam, and rival of the police chief within 1 hour. The locals on Mesa Rd. have been dispersed, but the HMMWV remains there temporarily. The second event theme is the mosque, where several of the insurgents from the fake position were seen entering. The team will plan to approach the mosque with the ICDC and then wisely switch to 1 PLT, when they learn of the rivalry between the Imam and police chief. The third event theme is the DHD area where the convoy finally arrives. 1 PLT leaves the detainee, MJ Toma, with the ICDC as they go to the mosque, taking Specialist James of the ICDC Patrol with them as an interpreter.

Table 4 (Continued)
Synopses of the Eight Frames in Block 4

Frame	Synopsis
13	The action is spread across four locations in Frame 13, with four main event themes. The first event theme is the Crackhouse operation, where 2nd Platoon is pushing to rush the CH. Meanwhile, the Bn CDR is pushing for waiting, which 2 PLT will comply with for another 30 minutes barring imminent danger to hostages. On the Westside, the HMMWV and Soldiers on Mesa remain on Mesa. The second event theme is the mosque, where 1st Platoon surrounds the mosque and has Specialist James attempt to communicate with occupants via a megaphone, as the Kiowa remains to provide eyes on target. The third event theme is in the DHD area where the HMMWV is being loaded. They confirm a return route, and division of troops and vehicles to assist at the mosque. In the meantime, Tubbs interrogates the prisoner who argues that the police chief and ICDC are the biggest crooks in town. The fourth event theme is the police chief gathering the ICDC reserves and taking Riyadh Khaled Hakeem (the bargaining chip) away at gunpoint, saying that he will teach that over-privileged cleric (the Imam) a lesson. The team will need to determine the police chief's and the enemy's reactions, along with possible destinations and warn the troops.
14	The action is spread across three main areas in Frame 14. The first area is the Crackhouse operations, where 2nd Platoon reports that the 2nd Floor CH blinds have been closed and the farmhouse reports seeing armed Iraqis north of Aragon, possibly fleeing from the fake position. The Kiowa is called in to check out the armed Iraqis, and when they open fire, the Kiowa eliminates them. The second area is the DHD, where at the start of the frame the police chief arrives and takes the ICDC patrol with him, saying they are going to the mosque but go west towards the Crackhouse. The team will use several other clues to figure out this misdirection, as the wrecker finishes loading and the convoy gets underway at the end of the frame. The third area is the mosque, where the ICDC LNO and Bn CDR advise treading carefully to prevent a riot. Specialist James communicates with the Imam, who offers asylum to his followers but offers to make a peaceful solution to both the mosque and Crackhouse situations. Specialist James interprets this as a positive sign, while 1 PLT interprets it as arrogance. Brigade sends the S-2 a picture and intel on a known insurgent, Kadar Kamil Abd-allah, who is hiding in the mosque. He will play a role in upcoming frames.
15	The action is spread across two main areas in Frame 15. The first area is the Crackhouse operations where, through untimely information exchange, the Police Chief was recognized and passed through the outer cordon and is heading for the Crackhouse. The inner cordon is advised to hold their positions out of sight, possibly using the police chief as a diversion to rush the Crackhouse. The second area is the mosque, where the Imam offers to arrange the return of the hostages and a peaceful solution if his demands are met. One of these demands is removing the police chief from office. The team arranges a secure phone line between Specialist James and the Imam. They are in the process of negotiating the release of one hostage as a sign of good faith, and to show that the Imam has influential control on the kidnappers. In the second story of the mosque, a 1 PLT Soldier spots and takes a picture of an insurgent (which will be identified as K.K. Abd-allah). The Bn CDR does not want to let K.K. Abd-allah, a wanted and dangerous insurgent, go free.
16	The action is spread across two main areas in Frame 16, but the events are intricately intertwined. The first area is the Crackhouse operations, where the police chief has Riyadh Khaled Hakeem with a gun to his back while yelling at the Crackhouse. The police chief flies off the handle when the Imam makes him look like a fool by ordering the release of a hostage and calling the police chief on the phone to taunt him. When the police chief starts shooting at the Crackhouse, 2nd Platoon steps in and detains him. When the frame ends, people are coming out the back door of the CH. The second area is the mosque, where the Imam complies to have a hostage released and agrees to the Bn CDR's additional demands to give up K.K. Abd-allah once the rest of the people in the mosque are safe. When everything appears to be coming to a peaceful closure, Sgt. Tubbs sees a guy in the 2nd Floor window with a gun. As a side note, during the mayhem at the Crackhouse and Mosque, the convoy makes it safely back to Basecamp Tiger.

SAMEPAGE TECHNICAL DEMONSTRATION

This section provides a brief description of a formative evaluation that was conducted on the SamePage training system at the 63rd Regional Readiness Command (RRC) at Los Alamitos, California. The twin purposes of this assessment, which also served as a technical demonstration, were to (a) content-validate the materials and (b) solicit user reaction concerning the usability of the instruction and scenarios.

Approach

Four groups of participants were given a 3-hour exposure to the SamePage training system. The short timeframe limited the amount of training material that could be received, and necessitated a "mid-course correction" on the second day of the tryout. On the first day, with the first two groups, we attempted to cover considerable portions of the Block 1 and Block 2 training materials in advance of the Block 3 tactical mission scenario. Because it took longer than we expected for participants to complete the individual training, these first two groups were only able to get through the first frame of Block 3. On the second day, we provided a more extended overview briefing, one that covered elements of Blocks 1 and 2, and then had the participants move directly into Block 3. This allowed us to complete Frames 1-4 for the third and fourth groups.

Each group was drawn from a different branch specialty, which included combat support (CSB), medical corpsmen (CSH), maintenance (MT Bn), and quartermaster (QM Bn) battalions. All participants had considerable battalion staff experience, some having served as S1, S2, S3, S4, and S5 staff officers. Also, each group had a senior officer who was naturally designated as the XO. Thus, our groups should be considered relatively mature, having worked together for a considerable period prior to our tryout. For the first group, all five team member positions were actual participants. In Groups 2-3, SamePage project staff supplied the S5. In Group 4, we supplied both the S4 and the S5. In total, 16 Army personnel were exposed to the SamePage training system during the weekend tryout period. The subjects were varied in background and experience; they were roughly split between officers and enlisted personnel.

The tryout was hosted in the 63rd RRC's upstairs conference room. Though it had an open hallway access to foot traffic, its ample space allowed convenient placement of a large conference table for participants to sit in front of their SamePage laptops, with a second table used for the group roundtable discussions. Anacapa project staff included an ex-Army instructor/facilitator (I/F), a scientist to help the I/F, an information technologist (IT) to monitor and maintain the local area network (LAN) server that ran the system, and two scientists to collect (independently) process measures of shared understanding (SU). The contract monitor also was present. A seventh scientist was also periodically present (she was conducting tests of another Anacapa training system in an adjacent room), and actually served as the S4 in our fourth tryout group.

In the following subsection, we provide a selective review of the qualitative results of our assessment. These reflect a distillation of comments provided by the project staff and the COTR, who was also present. We have organized the comments into ten topic areas, omitted the

redundancies in comments across staff members, and have not attempted to tally the reactions in any way. In some cases, the staff member comments reflect statements made by the military users of the system; in others, the comments represent observations of system use by one of us.

Observations

User Interface

In general, participants had little trouble getting comfortable with the interface. They all viewed the four-minute instructional video on the interface prior to starting the Block 3 scenario. Once the scenario started, the project staff provided occasional help to participants to clear up misunderstandings and help them through necessary functionality. While overall reaction to the system was positive, the major issues that arose during participants' use of the interface are summarized below.

To the extent possible, the incoming and out-going Comms window should function like a standard Outlook e-mail system. This would include the ability to (a) forward a message with a button press, (b) reply to a message with a button press, (c) copy and paste messages, and (d) reply to ALL team members without having to click each individual recipient. Another Outlook-like feature that was desired was to have the messages arrive in the inbox with the most recent message on top, instead of on the bottom as was presently the case. This change was implemented following the evaluation. Along with the standard Outlook functionality would be the ability to have "threads" of messages appear, where previous related messages are sent along with the new message, instead of having to create each message (and context) from scratch. Some participants also expressed a desire to have:

- color-coding of messages by different team members
- prioritization of communications
- creation of an optional subject line for each message
- bigger font size for the messages

Due to resource constraints, these changes were not implemented in this phase of the project.

The automatic scroll (when a new message comes in) of the message line in the incoming Comm window was found to be disorienting and should be disabled when users have clicked inside the message window. This change was implemented following the demonstration.

Having an inbox for Comms, as there is for Attachments, would be helpful for organizing one's Comms as the scenario progresses. As well, several participants found the frequent shifting between the Communicator Tab and the Workspace Tab to be distraction. Although users learned to make the transition, it is clear that the shifting is less than optimal. Some thought would be required in future research to redesign the interface layout so that extra button pushes are eliminated.

Several users expressed a desire to have an interactive shared map (like Blue Force tracking) similar to our Friendly and Enemy table. The ability to place symbols on the map, not just annotations, was also requested. As part of this capability, having a "virtual" ruler, rather than the plastic rules we placed next to each station, would help them measure the 100m distances from road intersections. This is another capability enhancement that should be investigated in future research.

Along these lines, the possibility was suggested that there be a common tab for maps/tables that would, in effect, replace the Workspace tab. Then, the Communicator tab would be used to present just messages, which could then be shown at full-screen size. Also, several participants asked for the ability to resize the Comm window. However, this need would go away if there was a change in how the Communicator and Workspace tabs were arranged. A related function request was the ability to cut/paste entries from the threat/friendly table into communications. These were all excellent ideas and were incorporated into a final list of interface functions that are recommended for future enhancements to SamePage.

The ability to forward advice and annotate information in the advice window was also requested. Participants also wanted to know who else had gotten the advice. In short, they want the Advice window to have the same functionality as any e-mail message. This enhancement proved too much for the Phase II and will await a further augmentation of the project. Several participants requested that the messages be time-stamped so they could see how long ago a message (one they may have been ignoring) was sent. This change was implemented in the final version of SamePage.

I/F Interface

The sessions for all four groups went smoothly. The demonstration I/F, and his assistant, had already had considerable practice operating the SamePage system, so they were very familiar with how the system operated. Consequently, few issues arose in using the system, but the issues that did arise are noted below.

Importantly, the entire right-hand side of the I/F's screen should be used just for incoming communications from trainees. In essence, the Comm monitor concept should be replaced with a large "incoming" box. Since the I/F primarily monitors trainee communications during this portion of the training, the I/F screen should be maximally sized for viewing rather than built for manipulating or moving messages. This change was implemented subsequent to the demonstration.

A second issue involves I/F workload and cognitive load during the SamePage exercise. Because our I/Fs were relatively familiar with the training system and content, they did not encounter much difficulty in using the system. However, trainers less familiar with the system might have some difficulty in monitoring trainee communications, preparing to deliver feedback to trainees during roundtable discussions, and role-playing various characters in the exercise (such as Brigade Headquarters). Though we did not do this at Los Alamitos, the browser-based capability of SamePage permits multiple I/Fs to be signed onto the server. This could be used to

offload some of the duties of a single I/F, so that one I/F could monitor the training while a second would be responsible for role-playing characters in the exercise).

Roundtable Discussions

The formative evaluation also addressed the quality and process through which the roundtable discussions were held. As noted above, we were only able to observe a limited number of these: two discussions each were held with the first two groups (they went through Frame 1), while five discussions were held for the second two groups.

First, a detailed instructor's manual is required to help an instructor run through this exercise. As a result of this experience, we developed an extensive Instructor Guidebook (Holder et al, 2006). Part of the manual is devoted to the technical aspects of running the scenarios, while another part addresses how to run a structured round table discussion. The goal of the round table should not be so much to gain consensus of the team members, but *to train people how* to achieve reasonable consensus (i.e., meta-understanding—understanding of how to achieve understanding). The instructor's manual provides examples of things the instructor should look for in roundtable discussions as "teachable moments." The manual also provides an indication of how the instructor should provide feedback at the end of every exercise.

Second, each roundtable exercise should begin with an overview of the purpose for the exercise. This was not always clear during the demonstration, which partly reflects the need for modifying the Block 2 training material. Also, instructors should work from a template of structured questions, and while much of what goes on during a roundtable exercise should be at the discretion of the instructor, the instructor should be able to fall back on the manual to guide discussion. These guiding questions were developed for each frame and have been included in the Guidebook.

Much of the roundtable discussions of the preceding scenario frame were devoted to reconstructing who said what to whom. The discussions would be streamlined, and aided, if the system could print out the entire communications protocol, time-stamped, from the just-ended frame. The XO (or I/F if he/she is leading the discussion) could then refer to that protocol during the discussion. This is a capability that could be readily incorporated in a follow-on version of SamePage.

The roundtable discussions, in general, were useful and clearly shed considerable light on shared understanding. They were also instrumental in "recalibrating" the SU for each group. It would be difficult to duplicate the training value of these interactions within an entirely distance learning system. Thus, while some of the instruction can and should be relegated to home-based individual instruction (see sections below), there will always be a core aspect of this training that is team-based requiring face-to-face interactions.

Interface Introductory Video

Because of time and resource constraints, we were not able to package a full-up, hands-on instructional module that would have guided users through the features of the interface in detail.

However, the brief, 4-minute video did serve as a useful “model” for how we can begin to convey interface functionality over the Web. It was clear, however, that after the video, users still required some help in learning and understanding many of the key aspects of the interface.

Students will need more time allocated in the SamePage system to learn the interface, with the video serving as one part of interface training. One improvement would be the incorporation of a “key features” section that covers some of the things users need to know up front, such as switching between the Communicator and Workspace tabs, what the Advice window is for, reminding them of the threat and friendly tables, and discussing how and why the Monitor tab should be used. They will also need to be reminded of the less-used features, such as the Task Designator and Instructional Window.

Reports from project staff that used the video for their own instruction indicated that while the video explained the interface pretty well, it is difficult to stay focused if there is extraneous noise in the room. Also, the pace of the instruction was brisk, so that a button or tab would be introduced and the explanation would follow before the user had time to find it. Although the cursor served as a visual cue for what is to be discussed, verbal accompaniment would help. For example, instead of saying, "Button X opens up this window..." we could say, "Button X, in the bottom right corner..." or "Below the incoming message window is button X, which...." Or maybe have color annotation (e.g., a large red arrow pointing to the button). Such enhancements can be readily made through recording new video segments with minor alterations in the voice-over script, utilizing the narration capability of the Window Media Encoder screen-capturing software that was used to create the video. All the pieces would then be “re-spliced” together and formatted electronically utilizing video editing software (Pinnacle Studio 9 and DeskShare’s Video Edit Magic 4).

There were a couple of minor glitches in the video (such as a double click instead of a click in one segment) that will be corrected in the next version, as will modifications to support interface improvements added after the video was completed (e.g., new messages coming in at the top vice bottom now in the comms and attachment window).

SU Measurement

The measurement process and the measures collected were successful in this demonstration. Because of time constraints, our SU probes and team self assessment ratings were done via paper-and-pencil instead of by computer. Subsequent to the demonstration, these measures were computerized and thus will be available as feedback to the users during the roundtable discussions.

The team self assessment measures proved useful to the XO in “priming” his/her efforts toward the next group discussion. In effect, these measures can help create a 360-like measurement environment in which convergence from multiple perspectives is strived for.

As the system matures, it would be helpful to have automated measurement of the communication matrices during the preceding frame (i.e., who sent messages to whom, how often and for how long) that can be used along with the rating measures to give the team

feedback concerning their SU. These frequency counts will be helpful for identifying asymmetries in communication that could be worked out during the roundtable. In this vein, there is an open issue concerning the team self assessment index, and whether the ratings reflect the individual's assessment of the team as a whole or their own "personal level of confusion." Further use of the system will help determine which assessment is more likely, even though the instructions are to rate one's own team.

In the interval between frames, during roundtable discussion, we could present the team with the average of their self assessment ratings. This would let the team know how they did as a whole. We could also give them the tallies on how they did on the SU-focused probe questions. We were not able to do this in the tryout because of time constraints and because the measures were not computerized. We will hopefully be able to incorporate this feedback into the instructional flow as SamePage development continues. We believe that the SU-focused probes (at the beginning of the interval) and look-ahead probes (at the end of the interval) do double-duty as measurement and education devices. We will want to continue exploiting their benefits in SamePage training.

The inter-rater agreement of the team assessment measure was high during the technical demonstration. In three of the groups, our two observers generated identical ratings for the groups across frames. In the other group, the observers differed by only 1 rating point. This level of agreement is encouraging, and argues that the behavioral anchors present in the scale (confusion, backing up, being in synch) are readily observable, where levels of these phenomena can be reliably gauged by different people.

Opening Instructions to Users

The overview instructions to SamePage users are very important, and it was clear that the overview provided by the researcher on Day 2 was more successful than Day 1. Two points were hit harder on the second day to answer trainee questions and comments that arose during the first day of demonstrations. The first was to explain that SamePage is *not* replacing any operational communication system—it is for training purposes only. The second was to clearly articulate SamePage's role within the Army's Military Decision Making Process (MDMP). In this regard, it was important to show how the present Situation/Mission/Team dimensional breakout of the Shared Understanding conceptual model had ties to the MDMP. Both of these points were explained and incorporated into revised Block 1 materials.

Providing users with the "big picture" for why the training is being conducted is a major part of the introductory session and must be accomplished with care. The introductory overview should describe the instructional flow of events, how SamePage tries to build SU in teams, and how the SamePage cue cards and training methods fit in to the concept of training SU. These points were all addressed in a revision of the Block 1 materials following the demonstration.

Block 3 Scenario

It was clear that the pace of the scenario, at least in the initial frames, was too quick for trainees. This was due to a combination of things, including lack of training time, unfamiliarity

with the interface, and some negative transfer between Outlook and the present communication system. A simple solution might be to double the length of time for each frame so that users are not overloaded. Alternatively, we could modify the communication features of the interface (e.g., adding cut/paste capability). Subsequent to the demonstration, we opted for a "middle ground" modification, in which frame length was increased somewhat and some aspects of the interface were modified. Inserting a pause after the first 30 seconds of the first frame was clearly necessary, and is something that should be retained as part of the instructional approach. This allowed our researchers to provide additional guidance to users on how to use the interface.

It was clear that the scenario proceeded more smoothly when **all** team members were minimally competent with the interface. This was apparent when one of the groups had a team member who clearly lagged behind his teammates, thus requiring considerable direct intervention to keep things running in a timely manner. This suggests that we may need to consider some type of criterion-referenced assessment of interface knowledge and operation before proceeding with Block 3. This point remains an open issue with the system and will require follow-on research to fully resolve.

Additionally, we need to conduct a thorough analysis of Block 3 mission frames to determine the feasibility of inserting SU prompts at certain points in the frame, broken out by team member position. This will be designed to lead to greater SU and, hopefully, better mission performance. While the Advice feature is designed to help individual team members with their *technical* tasks, we still need to ensure that adequate *SU* training is provided within each frame. These SU prompts would be faded out over frames, and would be completed removed by Block 4. Unfortunately, the time and resource constraints of the project prevented us from incorporating intra-frame prompts into the system. This is something that should be considered for any follow-on revisions to SamePage.

The content of the scenario was clearly successful and it is evident that we have captured a well content-validated set of scenario events. That said, we should look into the possibility of using a tactical, SOP-like framework for representing team member roles and responsibilities. This possibility remains an open issue and will require additional R&D support to become a permanent part of the system.

There are some scenario-specific points that need to be examined in more detail to ensure authenticity. For example, we now know there is only room for 4 people in a HMMWV, so we need to have a way to bring the DHD people back or a way to turn another HMMWV over to them; they would not proceed unchaperoned, and we need an excuse for one of the platoon's absence. Also, one of our experienced XO's recognized that the situation was starting to get bigger than the battalion could handle, so they might be asking for more brigade help (our I/F denied the XO's request for Brigade help; we'll need to provide a plausible excuse for this decision). We will have to go through Blocks 3 and 4, frame by frame, to fully vet the logic of our scenario event decisions to ensure that we do not have any unwelcome surprises as we demonstrate the system to other experienced military personnel. This analysis was in fact performed after the demonstration and the technical issues discussed above were resolved.

Because our student-users will vary in experience and knowledge, we will need to provide a timely discussion and presentation of key information points to keep the scenario moving early in Block 3. Thus, they need to know what a Kiowa is (and that it has weapons), what an S-2 does, what Al Jazeera is, and so forth. For certain training audiences, our team member packets should include this information, and we have to ensure that our training covers these points so that the scenario action can proceed with accurate technical knowledge by our students. A complete resolution of this issue would require a more comprehensive definition of the target audience for SamePage that exists at present.

Repetition will be key to getting our points across during the Block 3 mission. Some of the SU points are subtle, and it may take several exposures for students to understand where and how SU has broken down. This is due to the pace of events, the large amount of material being absorbed, and the novelty of the interface. The roundtable discussions are critical for this understanding to occur, of course. Inclusion of SU prompts, as noted above, will certainly facilitate this learning.

All participants expressed interest in using the system again, with scenarios customized to their mission focus. Indeed, the XO of the 419th QM BN, the last group we tested, wanted to use SamePage the following week in one of their Post Exercises. Thus, modifying SamePage to address a maintenance battalion, combat support, medical corpsman, or quartermaster scenario would be desired by the respective communities. We are exploring, and will continue to explore, the software implications (as separate from the content requirements) of expanding SamePage functionality to accommodate generation of new team-focused scenarios. This capability should be feasible with only a modest infusion of additional funding.

Use of Cue Cards

For a number of reasons, the cue cards (6/5/7 synchronization, dimensions, signs of SU presence/absence) were not used by trainees as much as we would like. Because our Blocks 1-2 instruction was truncated because of time constraints, we were not able to cover in detail how and why the cards would be used.

Also, we need to embed the cue cards more in Block 3 activities, both within the frame and definitely in the roundtable. We should keep a set of cards positioned at the roundtable site, so users might feel more compelled to use them. A key aspect of their utilization will be "modeling" by the I/F, which could then establish a pattern for how the team would self-correct their SU for the subsequent frames. These suggestions have been incorporated into the Instructor Guidebook.

Another impetus for using the cards is tying them in to discussions that reference actions and events that took place during the frames. By couching our discussions in terms of the SU dimensions, and making the dimension definitions available via the cards, this will help promote card use, thereby increasing the long-term value of the training. This, too, has been suggested within the Instructor Guidebook.

Training Materials for Blocks 1-2

In hindsight, we should not have attempted to provide Block 1 instruction within the constraints of a three-hour session. Instead, Block 1 should have been supplied as read-ahead or spin-up training material. As discussed in the following section, we believe SamePage should be packaged as a combination of (read-ahead) individual instruction followed by group exercises, team mission scenarios, and roundtable discussions. The specific breakouts of this individual versus team-training became part of the revised training flow that reflects our present system.

The Block 1-2 materials are comprehensive in scope and cover the conceptual underpinnings of our SU notions. That said, there will be a need to make the training more interactive, graphic, and further integrated into the Army's preferred style of instruction. Subsequent to the demonstration tryout, we performed an extensive review and revision of the materials following the steps laid out in the Development section discussed previously.

We discovered that TM, as an acronym for team member, invites confusion with Technical Manual by trainees. We subsequently removed references to TM in all training materials.

Several participants wanted the ability to communicate with other team members in Block 2. Presently, only communications with the I/F are allowed in Block 2. Subsequent to the demonstration, we drastically revised the format and structure for Block 2, so that some of the exercises are now team-based. The development of a shared data table is integral to this desired intra-team communication.

Overall Reaction to the Training

Overall, the four-group tryout supplied informative feedback concerning the content of our training materials, the SU development processes that were employed, and user reaction to training concepts and scenarios. The observations recorded by the project staff during this period served to inform the remainder of the project, as we completed scenario development and continued to refine the user interface.

Moreover, the networking of the computers via LAN (vs. public Internet) proved successful, and certainly reduced the risk of any server downtime. Importantly, this gives the user community two technical options—LAN or Internet—for using the SamePage training system in the future. The SamePage system delivered at the end of Phase II was markedly different, and we believe vastly superior, to the version shown participants in the technical demonstration. In the concluding section, we summarize the major lessons learned from the project and we outline some subsequent steps that could be taken by the Army to ensure that SamePage eventually reaches a larger audience.

SAMEPAGE – LESSONS LEARNED

As chronicled in the previous sections, we made a number of missteps early in the project that caused problems and created delays in delivering the final training materials. We describe six lessons that were learned during the course of this project. It is our hope that discussion of these lessons will inform researchers in the future so that some of these "potholes" can be avoided. Our intent in describing the following six lessons learned is to offer a candid accounting of how we would conduct the project had we the chance to do it again.

Lesson 1: Keep instructional materials short, interactive, and simple

Research from the multi-media literature (e.g., Mayer, 2001) clearly supports the position that instructional materials should be concise, with a minimum of reading required. Where possible, animation and visual depiction of processes and concepts should be the primary method of delivery. In that vein, an effective approach, one that we adopted later in the project, was to use PowerPoint as the prototype delivery medium rather than Word. The use of PowerPoint requires that the content developer keep his/her points short and simple, where links and interactivity can be anticipated and, in some cases, actually incorporated into the content development scheme. The use of simple instructional content delivery is not only effective for Army trainees, but is the preferred approach for all trainees. We now know that the student's working memory will be quickly overwhelmed with extensive verbal material, particularly when complex skill acquisition is the ultimate goal. Consequently, not only should training content be reviewed for technical accuracy and quality before it is rendered in software, but it should also be assessed for adherence to a short, to-the-point design philosophy.

Lesson 2: Model development is important but should not be the central focus

While having a theoretical basis for one's training content is important, it should not become the overriding theme of the project. In this regard, we may have devoted too much time early in Phase II to creating the "perfect" conceptual model, at the expense of actual training content development. Because the area of shared understanding was not well-studied, it was only natural to spend some time early on developing concepts and proposing hypothetical relationships that could be used in guiding research and constructing measures. Indeed, much model development was accomplished in Phase I and, while promising, the complexity of the SU area is such that we did not have a completely useable product at the end of that six-month period. Despite this, it would have served the project better to have limited continued model development to the first three months of Phase II rather than letting it extend into six months and beyond. Thus, a more prudent approach is to create a basic conceptual model as soon as possible, and then refine it as needed *while* training content is being developed and prototyped. Looking back, we can now see that much of the content that was ultimately developed did not need to wait for the conceptual model to be completed before proceeding. Hence, simultaneous model and content development is not only possible, but is desirable.

Lesson 3: Operators must always be kept in the design loop

Operators from the 3 ACR and 4th ID (Fort Carson) and 663 RRC (Los Alamitos) made invaluable contributions to the scenario and system development during the middle stages of the project. Our regret is that, due to the Army's high OPTEMPO, operator input could not be obtained sooner nor retained longer, throughout the life of the project. Sometimes referred to as user-centered design (McGraw & Harbison, 1997), the concept of having representative users interact with the system at varying stages of development is one of the surest ways to achieve ultimate success. Working under a spiral development process (see Lesson 4, below), select users can offer insightful design inputs as the system undergoes each new stage of maturation. In our case, we should have provided early storyboard concepts to operators in the opening stages of the project, worked with them more directly to identify scenario events, and solicited user feedback concerning the interface and roundtable discussion methods. Although it can add some upfront time (e.g., for visits, processing interview data, making re-design), the benefits are ultimately worthwhile as the system will achieve its intended effects with far fewer re-designs than if users are not consulted. While we are certainly appreciative for the user insights that we did receive during SamePage development, a continuity of user contact throughout the project is optimal.

Lesson 4: Spiral development is the most effective way to create prototype software

Spiral development is the most effective method for system construction, in which prototypes are built, tested, and refined repeatedly throughout the life of the project. For spiral development to occur, not only must the users be brought into the design loop early (see Lesson 3, above), but some system construction must occur early in the project, even in the form of static prototypes or mockups, so that users have something to react to. In an advanced R&D project such as SamePage, it is difficult to bring "pen to paper" to create early prototypes when one is still developing a conceptual model and defining user requirements. Nevertheless, true spiral development demands that the project team put forth, even before they are "ready," initial candidate display concepts and potential scenario events so that users can experience some aspects of the projected training environment. Rather than waiting until one has the final solution, the design team has to offer up an "80% solution," so there is something tangible to build on in subsequent spirals. This is admittedly a new way of doing business for a research organization, but it is one that is necessary so that both formative and summative evaluations can be conducted within the same project. Looking back, we were six months late in getting our first "design spiral" out to users for their review.

Lesson 5: Scenarios are effective for instilling motivation and permitting practice for skill development

We were encouraged by the positive reaction to the SamePage training that we received during the Los Alamitos technical demonstration. Having users receive the training in the context of a realistic, challenging scenario appeared to be a motivating experience for most participants. Because trainees were actively engaged in the scenario, they had incentives to continue interacting with the material, and as a result, they received extensive practice in the requisite skills. The capability of scenario based training to promote cognitive skill development through

repetitive, deliberate practice (Ericsson, Krampe, & Tesch-Romer, 1993) is a noteworthy finding, and encourages the continued application of the SamePage system beyond the life of this project.

Lesson 6: Team training is challenging, and involves more than simply summing individual training requirements

As we have learned from experience, it is best not to underestimate the difficulty and challenges involved in creating a team training system. Indeed, just creating the scenario, with multiple storylines and scripts (one for each team member), is an enormous challenge. Not only must the designer keep track of which team member is to communicate with which other(s), the two-, three-, and four-way interactive possibilities become unbelievably complex and vexing. Add to that the implications for interface design, along with the inclusion of constructive or role-played external entities, and one arrives at a myriad of system development choices, decisions, and tradeoffs. Put simply, building a team trainer for X (or in our case, five) team members is more than simply summing X individual training requirements. There are synergistic, multiplicative effects that result in a geometric expansion of complexity.

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Appendix A: OPORD

Note to trainees: The following scenario is fictionally based in a town near the Iraq-Syria border. The town of Belen (pronounced like Berlin without the "r") is actually in New Mexico. The border displayed is fictitious – positioned where it is in support of this exercise.

1st Battalion, 192d Infantry
Belen, Iraq
OPERATION ORDER #1 (JANUS)

Reference: Attached Map of Belen

Time Zone Used Throughout the Order: Local

Task Organization:

1-192 IN

- A/1-192IN
  - 1/A/1-192IN (Counter-mortar patrol)
  - 2/A/1-192IN (Reconnaissance patrol)
  - 3/A/1-192IN (Border Control check point)
- B/1-192IN (Border Patrol)
- C/1-192IN
- 1/A/1-4Avn (Kiowa, DS)

1. SITUATION
   a. Enemy Forces.
      (1) The threat here appears to be comprised of four different groups. First, the local criminals who are normal vandals and trouble-makers one finds in any community. This group takes up arms and engages our forces using hit- and-run tactics with RPGs and small arms. Next is the organized, local threat. These people are unemployed, military-trained personnel that engage for money. Third, there are the organized terrorist cells that plan more deliberately to achieve more dramatic results. Finally, there are the international terrorists who do not seek to strike in Belen, but to pass it by from Syria toward points further inward in Iraq.
      (2) Over the course of the last two weeks, there have been several indicators that the threat forces are accelerating their activities – possibly in anticipation of some important attack.

- In downtown Belen, there is an old three-story hotel locally known by US Forces as the Crackhouse. The Crackhouse has been the place where a variety of insurgents have made plans and laid ambushes. Recently, the Iraqi Civil Defense Corps (ICDC) has reported numerous suspicious outsiders going into and out of the Crackhouse.
- Brigade S2 reports that the network of insurgents that provides recruits for suicide missions has been particularly interested in Belen in the last two weeks.
- Al Jeezera vans have intermittently traveled up and down Ross Avenue with no apparent destination or object.
- Civilian ambulances with light flashing have been following US patrols – but at some distance.

b. Friendly Forces.

(1) Brigade Commander's Intent. We must create a secure civil environment in order to provide the opportunity for the Iraqi civil and law enforcement leadership to mature. I intend to do this on two thrusts. On one thrust, we will use our forces to seek out and defeat the criminals who threaten stability and Iraqi civic leadership. On another thrust, we will establish and nurture relationships with local civic, law enforcement, and religious leadership. Both of these thrusts succeed at the battalion level or they do not succeed at all. My headquarters is completely committed to supporting each of the battalion efforts, and to coordinate between them when necessary. I stand prepared personally to visit any civic or religious leader any time a battalion commander believes my presence will be helpful to his local efforts.

(2) Battalion Commander's long-term intent. We must establish security and stability to set the conditions for the Iraqis to govern and secure themselves. While we must be accessible to the local leadership and the local populace, we must provide room for the local civic leadership to mature. This will be a delicate balance. My subordinate commanders and I will personally establish and nurture relationships with the local civic and religious leaders. We will use the fullest extent of our force to search out and defeat the criminals and terrorists who challenge the secure environment we seek to establish.

(3) This unit "sits on the horns" of a tactical dilemma. The twin responsibilities—to secure the town and grow the Iraqi leadership—are in great contention with each other. If the battalion pulls its troops out of town so the local leadership can impose its own will, the insurgents see the US forces as weak and begin to terrorize the leadership and the citizenry. On the other hand, US forces positioned in town diminish the reputation of the local leaders, and they leave little room for maturation of civic leaders.

(4) Last fall, after the battalion had pulled all its Soldiers back to the base camp out of town, the insurgents assassinated the police chief, stormed the police station, and held the police there hostage until our quick reaction force (QRF) arrived. Before they left, the insurgents warned the police that "all collaborators with the American occupiers risk the safety of themselves and their Families."

(5) It was this incident that in large measure prompted the battalion to move forces into town and secure some of the more important symbols of authority – primarily the old Ba'athist Party HQ and the police station. In addition, we more rigorously patrolled 25-Bus from the Arches to the police station. This invited the insurgents to attack US forces, but at least we were fighting an enemy that did not seem like a phantom. The tactic eliminated many of the advantages the threat would ordinarily have, such as choosing where to fight and engage. Having occupied key terrain, US forces drew the threat to their positions.

(6) When showing strength in town, many of the Iraqis who might be inclined to support US efforts could more easily approach US troops and inform them of potential threats in town. Deployment of forces to key locations lasted about 60 days. Over that period, the local populace became much more cooperative. However, if the local leadership is ever to take charge, US forces must withdraw at some point. About a month ago, the battalion moved back to its base camps. So far, everything in town seems stable; however, it's only a matter of time before the organized insurgents infiltrate back into town and reassert themselves

(7) Routine disposition of the battalion now is one company in Base Camp Tiger, one company on border patrol, and one company executing a variety of missions in the city and at the border check point. This includes occupying the border checkpoint with Syria, maintaining one counter-mortar patrol and one reconnaissance patrol in Belen. A Company is presently pulling that duty.

2. MISSION. Within the next 72 hours, battalion staff will analyze Fwd 1 (Grid 812073) to determine its feasibility as a reinforced unit position forward staging area. Be prepared to plan and conduct a reconnaissance of Fwd 1 and the route(s) to it, in order to verify, refine, and complete the results of the analysis.

3. EXECUTION.

- Battalion commander's intent specific to this mission: I intend to position an infantry company forward. I chose Fwd 1 because it is on the edge of town with plenty of roads in and out of it. It appears close enough to town to display US presence, yet far enough away from City Hall and the Police Station to allow the local leadership room to grow. It is also close enough to the populace to continue to build vital, local intelligence. I intend for this analysis to highlight the strengths and weaknesses of this selection.

a. Concept of Operations. Led by the XO, the staff will accomplish the mission through four key tasks. Each task will be thoroughly investigated by an individual staff member, and the results of that analysis will be integrated into a complete analytical product. The four key tasks are:

(1) Evaluation of the road network between Base Camp Tiger and Fwd 1 to determine its adequacy as a logistical line. Adequacy of a logistical line involves a road or a route:

- That can support the passage of several 5T trucks and their concomitant security vehicles – up-Armored HMMWVs with 50 cal MK-19 weapon systems.

- That has few or no points along the way that have cover for ambushers – check closely for points along the route where buildings or other cover are close to the road.
- That has few opportunities for insurgents to bury IEDs. (A paved road is safer for our convoys than a dirt road.)

(2) Evaluation of Fwd 1 to determine if it is located properly in the vicinity of the local population. It should be close enough to the local Iraqis to provide easy and routine access between US troops and average Iraqi citizens. It should be far enough away to allow the local leadership to mature. This evaluation includes the following criteria:

- US Soldiers are easily accessible to walk up traffic – after, of course, an approaching Iraqi is cleared for any approach.
- US Soldiers can easily and routinely contact Iraqi citizens in a non-confrontational manner.
- US forces can protect the personal safety of approaching citizens.
- There is sufficient physical distance between Fwd #1 and the civilian leadership institutions to allow police patrols and other civil leadership to work, succeed, and prosper.

(3) Evaluation of possible enemy courses of action that might disrupt our purpose in occupying Fwd 1. The enemy's primary methods of disruption are to promote fear and distrust – fear of them and distrust of US forces. Determine whether US occupation of Fwd 1 will diminish, enhance, or remain unaffected the enemy's capacity to:

- Conduct criminal actions against the general populace to induce fear in them.
- Conduct criminal actions against local leadership to induce fear in them.
- Conduct criminal actions against the general populace and local leadership to demonstrate lack of capacity of US forces to protect them.
- Spread rumors that the US forces lack resolve to occupy Fwd 1 over a long period of time.

(4) Evaluation of Fwd 1 to determine if it is defensible by an infantry company. This evaluation includes the following criteria:

- How defensible is the terrain in and around Fwd 1 against a coordinated attack by dismounted forces?
- How defensible is the terrain in and around Fwd 1 against an infiltration of individual suicide bomber?
- How defensible is the terrain in and around Fwd 1 against a suicide car bomber?
- Is Fwd 1 drawn to the correct size? Too big? Too small?

- How will the structures in and around Fwd 1 affect its defense?

b. Rules of Engagement.

(1) US forces have the right to use force to defend themselves against attacks or threats of attack.

(2) Hostile fire may be returned effectively and promptly to stop a hostile act.

(3) When US forces are attacked by unarmed hostile elements, mobs, and/or rioters, US forces should use the minimum force necessary under the circumstances and proportional to the threat.

(4) Detention of civilians is authorized for security reasons or in self-defense.

(5) Civilian ambulances with lights flashing are normally to be left unhindered. However, if such ambulances look suspicious, US forces may detain them only to quickly determine if there is a real casualty situation, or if they are actually transporting hostile forces or contraband.

(6) Religious facilities may not be disturbed unless there is clear evidence of hostile and imminently dangerous activities going on there.

4. SERVICE SUPPORT.

a. 1-192 Infantry is a standard infantry battalion. That is, it is not mechanized. Prior to deployment the battalion was issued sufficient up-armored HMMWVs to equip two per squad. Of the pair in each squad, one is mounted with an M2 .50 Cal machine gun and the other is mounted with MK-19 40mm grenade machine gun.

b. Patrols and checkpoint operations in the city deploy with sufficient logistics to complete the mission and then return to Base Camp Tiger for re-supply.

c. When vehicles are disabled while on patrol, the patrol will attempt to tow the vehicle into Base Camp Tiger. However, patrols will leave a security detachment with the vehicle and call Battalion maintenance in the following instances:

(1) The vehicle is disabled in such a fashion that it cannot be easily towed.

(2) The patrol leader decides that his ongoing mission prohibits him from towing the vehicle.

5. COMMAND AND SIGNAL.

a. Command. No change from TACSOP.

b. Signal. Team members will alternately work together at individual computer work stations and around a conference table.

Schmidlap
LTC
Commanding

Appendix B: Glossary of Acronyms

Acronym	Definition
ACR	armored cavalry regiment
AJ	Al Jazeera
AO	area of operations
AOR	area of responsibility
ARI	Army Research Institute
BCT	brigade combat team
BDE	brigade
BN	battalion
C2	command & control
CDR	commander
CH	crackhouse
CONUS	continental United States
CSB	combat support battalion
(CT)2	computerized training in critical thinking
DHD	disabled HMMWV detachment
DHTML	dynamic hypertext markup language
FRAGO	fragmentary order
HTA	hypertext application
ICDC	Iraqi Civil Defense Corps
ID	infantry division
IED	improved explosive device
I/F	instructor/facilitator
IMI	interactive multi-media instruction
JAG	Judge Advocate General
LAN	local area network
LNO	liaison officer
MB	mega-byte
MOOTW	military operations other than war
MS	Microsoft
MT	maintenance
OIF	Operation Iraqi Freedom

OPORD	operations order
PIR	priority information request
PLT	platoon
QM	quartermaster
QRF	quick reaction force
ROE	rules of engagement
RPG	rocket-propelled grenade
RRC	Regional Readiness Command
SASO	Stabilization and support operations
SIPRNET	Secret Internet Protocol Router Network
SITREP	situation report
SME	subject matter expert
SMMs	shared mental models
SU	shared understanding
TCP/ICP	transmission control protocol/internet protocol
TOC	tactical operations center
UAV	unmanned aerial vehicle
UO	urban operations
Vic	vicinity
VPS	virtual private server
WAN	wide area network
XO	executive officer